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DISEASES OF THE BONES.

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DISEASES OF THE BONES:

THEIR

PATHOLOGY, DIAGNOSIS, AND
TREATMENT.

BY

THOMAS JONES, F.R.C.S. ENG., B.S. LOND.,

SURGEON TO THE MANCHESTER ROYAL INFIRMARY;
LECTURER ON PRACTICAL SURGERY IN THE OWENS COLLEGE, VICTORIA UNIVERSITY;
CONSULTING SURGEON TO THE CHILDREN'S HOSPITAL, PENDLEBURY, MANCHESTER.

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P R E F A C E.

THIS work is offered to students and practitioners as an exposition of our present knowledge of the important diseases of the osseous system ; in writing it I have constantly endeavoured to regard them from a clinical standpoint, and to this view all other considerations are subordinated ; and, as far as possible, no facts are stated which have not been verified by my own observation.

No attempt has been made in the first chapter to present an exhaustive description of the structure and functions of bone, only such facts being mentioned as are deemed necessary to make the rest of the work intelligible.

Except when otherwise stated, the cases reported have been under my own care.

I have much pleasure in thanking Sir James Paget, Dr. Macalister, Mr. Birkett, Mr. Bryant, Mr. Holmes, and several of my colleagues at the Manchester Royal Infirmary, for permission to use illustrations and cases.

My indebtedness is also great to several friends and former pupils, and especially to Mr. Leopold Larmuth, for valuable assistance cheerfully rendered in revising proofs.

The specimens from which the majority of the illustrations are taken are to be found in the museum of the Owens College; and to the Council and the Curators, Professor Dreschfeld and Professor Young, my thanks are due for permission to use them. With regard to the illustrations, I may say that they are entirely the work of Manchester artists, and I cannot leave unacknowledged my obligation to the facile pencil of Mr. W. Tomlinson, who has supplied the drawings and also executed the etchings.

96, MOSLEY STREET,

October, 1887.

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BONE DISEASES.

CHAPTER I.

BONE is made up of one-third animal matter blended with two-thirds earthy salts, the whole forming a complex structure. Each constituent may be separated by suitable processes, the shape of the original bone being retained. The animal portion is destroyed by calcination, while the earthy salts are removed by digestion in dilute hydrochloric acid. The animal matter consists of a substance which, on boiling, is converted almost entirely into gelatin. The earthy salts are phosphate and carbonate of lime, fluoride of calcium, phosphate of magnesia and soda, and chloride of sodium.

Texture.—Bone tissue exhibits two varieties, called respectively the compact substance and the spongy tissue. The former is that dense, white structure, of more or less thickness, situated beneath the periosteum in the shafts of long bones. It is composed of lamellæ or plates arranged concentrically around the Haversian canals, those near the medullary canal forming imperfect circles whose extremities overlap; while in the spaces between adjacent Haversian systems we meet with incomplete lamellæ, the segments of circles of much larger diameter than those forming the lamellæ of the systems themselves. In the lamellæ we find prolongations of Sharpey's elastic fibres. A transverse section of a bone examined with a microscope displays, besides the rings encircling the Haversian canals, small ovoid irregular bodies, osseous corpuscles, with

numerous prolongations situated in the thickness of and between the lamellæ, and presenting an appearance which has been not inaptly compared to one of the myriapod insects. The corpuscles are in cavities (lacunæ), with fine tubes (canaliculi) springing from their periphery. These ramify in all directions and join by their extremities the canaliculi arising from contiguous lacunæ. The presence of a cell in each cavity was demonstrated by Virchow (1850), and he was able to separate it with its prolongations which entered along the canaliculi after steeping a bone in hydrochloric acid. The ramifications of the canaliculi constitute an irrigation system for the distribution to the osseous tissue of the nutritive fluids derived from the Haversian canals. The lamellæ consist of transparent fibres which cross each other so as to produce a delicate network. Passing through the lamellæ, either perpendicularly or obliquely, are some fibres which appear to serve the purpose of fastening them together. In the spongy tissue, or cancellous structure, the lamellæ no longer form regular stratiform layers; we find, instead of them, a number of thin plates or delicate partitions enclosing spaces or areolæ of different sizes, distinctly visible to the naked eye and communicating with each other. There is no distinct line of demarcation between compact and spongy tissue, they gradually merge into each other, the interstices becoming smaller as we pass from the latter to the former.

Long bones are made up of a shaft or diaphysis and two extremities usually of considerable size (epiphyses). The shaft consists mainly of compact tissue; in its interior there is an elongated cavity formed from the spongy tissue by the disappearance of its bony partitions and the union of adjoining spaces. The medullary canal attains the greatest size in the middle of the diaphysis, and narrows gradually as we pass towards its extremities.

Epiphyses.—The epiphyses similar in texture to the short bones are composed of spongy tissue, surrounded by a thin layer of compact bone. The two epiphyses at the extremities

of a diaphysis freely communicate through the medium of the medullary canal into which both open. The importance of this fact is recognised in inflammation of bone, the disease spreading from one epiphysis to the other along the medullary canal.

Flat or large bones consist of two layers of compact tissue, with a variable amount of cancellous structure between them. In the skull the compact layers are named respectively the external and internal tables, while the intervening spongy tissue is called the diploe. In the thinner parts of the skull, as well as the scapula and ilium, the two compact layers are in close apposition, without any cancellous bone intervening. The ribs, which apparently belong to the type of long bones, exhibit a structure similar to that of the flat bones.

Periosteum, a greyish white, fibrous structure forming the external covering of the bone. Owing to the part which it takes in the production and regeneration of osseous tissue, its importance is estimated very highly. It varies in thickness in different regions, thinnest on the bones of the face, thickest on the under surface of the occipital bone. Its resistance is generally very considerable. The periosteum consists of two layers, the one composed of connective tissue and elastic fibres, with here and there some fat cells, the other the osteogenic layer. The superficial layer constitutes a fibrous membrane, with white fibres predominating in the outer portion of its thickness, elastic fibres becoming more numerous the nearer we get to its deeper limits. The osteogenic layer, seen best during the period of growth, is composed of a network of elastic fibres, in the meshes of which are found cells, which play an important part in the formation of bone during the time of development. That they do so is proved by a simple experiment (Ollier), a periosteal flap is detached and its under surface lightly scraped with a scalpel. New osseous tissue will not be produced under the portion of the flap so treated. The vessels of the periosteum ramify in this membrane before entering the bone by the Haversian canals or

penetrate the osseous tissue after simply traversing it. The presence of lymphatics in the periosteum may be demonstrated by treating the membrane with nitrate of silver (Quain). The nerves accompany the small arteries in their ramifications through the bone. They freely inosculate with branches from neighbouring nerves and belong for the most part to the sympathetic system. The periosteum entirely covers the bones except where the tendons and aponeuroses are attached, and with these it becomes blended in their intimate attachment to the subjacent bone. At the articular extremities the periosteum is replaced by cartilage, becomes continuous with the periarticular ligaments, and so passes to the adjacent bone, which it covers in the same way. The membrane is absent where two bones are joined by a fibro-cartilage.

Medulla of bone, marrow, or medullary tissue, occupies the central canal of long bones and the interstices of the spongy tissue. It accompanies the vessels in the Haversian canals, and in the opinion of many the osteogenic layer of the periosteum is to be regarded as a kind of peripheric expansion of the internal medullary system. The vascular areolar tissue lining the medullary and Haversian canals is sometimes looked upon as a distinct membrane—an internal periosteum or endosteum—which, however, is not separable as a continuous and distinct structure, like the periosteum covering the outside of a bone. This view was finally disposed of by Gosselin and Reynauld in 1849. The medullary tissue is a soft, pulpy mass of variable colour and consistence. In the young its colour is red (fœtal marrow); during the period of development it gradually assumes a yellowish tint, which becomes more pronounced as age advances. In the articular extremities of long bones and in the bones of the trunk the marrow retains its red or fœtal character a much longer period, and even it may be throughout life. The diaphysary marrow even in children has a yellowish tint, owing to the predominance of adipose cells.

Marrow is made up of (1) cellular elements, (2) amorphous substance and a fine network of connective tissue, (3) vessels and nerves. Cells of very varied character are observed in the medulla, and the exact relation which they bear to each other has yet to be determined; whether they form distinct varieties, or whether they result from the metamorphosis of embryonic cells, are points under discussion. Among the cell elements there is one which is regarded as characteristic of the marrow, the medulla cell of Robin. Two varieties of the medulla cell are met with, and always in association. One is spheroidal, slightly granular, with a round nucleus often containing a nucleolus, and approaching a white blood cell in size. Some of these cells possess a reddish colour, and bear a resemblance to the primitive red corpuscles of the embryo. The second variety contains free nuclei resembling the nucleus of the first variety described. There is still another cellular constituent of the marrow to be mentioned: the cell or plaque with multiple nuclei observed in the first instance by Müller in certain sarcomas of bone and discovered later by Robin in normal marrow. Robin's myeloplague consists of a mass of protoplasm, of irregular shape, composed of granular contents with generally a very considerable number of nuclei and large nucleoli. These elements are very rare in the normal state, except at the time when the compact tissue of bone is being hollowed out into cavities owing to the work of interstitial absorption, so that it would appear, as was pointed out by Kolliker, that the myeloplagues have a peculiar relationship to, and are closely connected with, the process of bone absorption. The fat cells, absent in the foetal marrow, gradually replace the other cellular elements, and bestow on the yellow marrow its peculiar colour and consistence. They are so abundant in the marrow within the shafts of long bones as to assume the characters of ordinary adipose tissue, and to constitute ninety-six per cent of the total marrow. Each cell has a distinct covering separated

from the fatty substance by a mass of protoplasm having a small nucleus. The cells cluster together without producing distinct lobules, as in other formations of adipose tissue. Scattered among the cell constituents of the marrow are a number of amorphous, semi-transparent bodies presenting a granular appearance.

Blood-vessels.—The bony tissue is abundantly supplied with blood, and may be regarded as one of the most vascular structures. On the shaft of a long bone there appears an orifice of variable size, to which the name nutrient foramen is given. From this a canal passes through the compact structure and terminates in the medullary canal. The circumference of long bones is in addition pierced by numerous small orifices, for the entrance of vessels, which orifices increase so as to become visible at the onset of inflammation of the bone. The non-articular portions of long bones, as well as the surface of short bones, are perforated in a similar manner by canals which open into the areolæ of the spongy osseous tissue. The surfaces of large or flat bones have a number of minute holes which permit vessels freely to enter their substance. The arterial supply of a bone is derived from two sources, one for the marrow and the other for the compact substance. The artery for the supply of the diaphysary marrow enters the nutrient foramen, gives some small branches to the compact tissue, and bifurcates into two principal branches, one ascending, the other descending. These divide and subdivide into numerous branches, which, in conjunction with the connective tissue supporting them, form a delicate framework, in the meshes of which the cell components of the marrow are contained. At each end of the medullary canal the ramifications of the nutrient artery inosculate with the arteries supplying the epiphysal marrow.

The second set of vessels destined for the compact substance is derived from the arterial network in the periosteum covering the shaft. They enter the orifices freely scattered

over the surface of the diaphysis and anastomose with branches derived from the medullary vessels. In this manner free communication is established between the periosteal vessels and those of the marrow. The epiphyses obtain their blood supply from the periosteal arterial network, branches from which perforate the thin covering of compact tissue and are distributed throughout the spongy structure. An analogous arrangement exists in the short bones.

According to some observers (Todd and Bowman) the veins occupy distinct channels, and on the larger ones pouch-like dilatations are to be found. Others believe that the veins, with the exception of those of the skull, follow the course of the arteries. In the long bones the veins which correspond with the principal divisions of the nutrient artery reach the extremities of the shaft and join those issuing from the spongy tissue, and pass out in the vicinity of the articular surfaces. In the articular extremities of long bones, and in the spongy tissue of large and short bones, veins of a certain size are enclosed in canals formed of thin plates of bone, have very thin walls, and no muscular fibres competent to aid the progression of the blood. This peculiar arrangement is best seen in the diploe and in the bodies of the vertebræ; from both situations the veins emerge by distinct and particular openings of considerable dimensions.

As regards the lymphatics of bones, thus far nothing is really known concerning them. We may make almost the same observation about the nerves. They accompany the nutrient artery in the canal of this name, reach the marrow in which they are lost, their final destination being still uncertain. They belong for the most part to the sympathetic system. In the normal state marrow possesses little sensibility, but when inflamed it acquires a sensitiveness which is remarkable and often pathognomonic.

The encrusting or articular cartilages deserve a word of mention, in order to render complete the description of the component parts of a bone. In all situations where two bones

are in contact, and where mobility, and therefore friction, exists, the periosteum reaches as far as their extremities, and the layer of compact tissue which forms them is capped by a layer of hyaline cartilage of varying thickness. This cartilage is made up of characteristic cells or chondroplasts, and of an amorphous, homogeneous, intercellular substance. The free surface of the cartilage, smooth and glistening, is constantly moistened by the fluid secreted by the synovial membrane, which extends over it for a short distance. Where lying on the cartilage the membrane is strongly adherent, but the portion of articular cartilage in most frequent apposition with its fellow is devoid of synovial membrane. The line where the membrane ceases to cover the cartilage is not abrupt, but the epitheloid covering of cells belonging to the synovial membrane gradually gives place to true cartilage cells.

GROWTH AS OBSERVED IN THE LONG BONES.

A long bone grows in length as well as in thickness. Increase in length takes place at the extremities of the diaphysis, the epiphyses co-operating to a very small extent. Ossification, which commences in the centre of the diaphysis, extends towards its extremities until these are separated from the corresponding epiphysis by a thin layer of cartilage (cartilage of conjunction). Growth would cease if this cartilaginous layer ossified like the rest of the bone; but as its margins are encroached upon, an interstitial fresh zone of cartilage is produced by proliferation of the pre-existing cartilage, and a similar round of changes goes on without interruption so long as growth continues. The two ends of the diaphysis take an unequal share in the increase in length, in the tibia and humerus the upper ends, in the femur and bones of the forearm the lower ends, being most active. The importance of this will be observed when we come to consider inflammation of bone, the liability of the diaphysial extremities to attack being in direct proportion to the rate of growth.

The above facts, respecting the unequal rate of growth, have been demonstrated experimentally by Duhamel, Ollier, and others. Ollier inserted two small leaden nails into the osseous substance of a diaphysis, at determinated distances, and found them occupying the same relative distance when the animal had finished growing. If, on the contrary, he placed one of the nails in the diaphysis and the other in the epiphysis, their separation represented the amount of osseous tissue formed by the cartilage of conjunction which was included between them. By this means it was conclusively proved that the bones of the limbs grow unequally at their two extremities. In the upper extremity, both in the arm and in the forearm, the ends which co-operate to form the elbow grow the least. In the lower limb, both in the thigh and in the leg, it is the extremities which form the knee that grow the most. The diaphysary surface of the cartilage of conjunction has an osteogenic power twelve times greater than that of the epiphysary surface of the same cartilage, the ratio of growth being as twelve to one.

Direct irritation of the conjunctive cartilage arrests the growth of a bone in length, while indirect irritation, such as that produced by tearing off the periosteum from the diaphysis at some distance from the cartilage of conjunction, provokes the activity of this cartilage and induces hypertrophic lengthening of the bone. To effect this the irritation need not implicate the bone itself, but exist only in its vicinity. Poncet¹ relates an instance which occurred in a man fifty-six years of age, who for forty-two years had possessed an ulcer on the upper and inner surface of the left leg. Examination of the limb disclosed considerable difference in the length of the two tibiæ. The left tibia, which had never been the seat of an inflammatory attack, and which was not increased in volume, measured two centimetres more than that on the sound side.

¹ *Revue de Chirurgie*, Mars 10, 1886, p. 247.

PROPERTIES OF THE PERIOSTEUM.

The formation of bone from the periosteum was established by Duhamel,¹ confirmed by Syme,² Heine (1837), Flourens (1848), and notably by Ollier, who in 1858 published his first memoirs on Resections and Regeneration of Bone, giving the general results of his experiments respecting the reconstruction of joints by the sub-capsulo-periosteal method of resection. His *Traite Experimentale et Clinique de la Regeneration des Os* appeared between 1858 and 1867. Ollier's experiments showed ossification of the periosteal flap rolled up among the muscles of a limb. Bone also developed under the skin of the scalp of a dog from a periosteal flap taken from the tibia of the same animal. The ossifying properties of the periosteum were attributed exclusively to the osteogenic layer of young cells analogous to those of the marrow.

Growth in Thickness results from the deposition of a series of osseous layers between the deeper layer of the periosteum and the surface of the bone, the last formed layer being external and in contact with the preceding one. Growth of bone in thickness continues longer than growth in length. Sappey is of opinion that it ceases at thirty-five or forty years of age. Short bones increase in volume by the addition of new bony layers derived from the sub-periosteal blastema. While a bone is being developed by the superposition of new layers an important change is taking place in its interior, namely, softening and absorption of the osseous substance. The spongy areolæ and the medullary canal are thus formed. This change, which sets in immediately after the ossification of the temporary cartilage, continues not only through the period of development, but is indefinite and is carried on during the whole of life.

¹ *Memoirs*, 1739-43.

² On the Power of the Periosteum to Form Bone, *Contributions to Pathology and Practice of Surgery*, Edin., 1842.

Local and General Troubles dependent on Growth.—These include affections which are the direct result of rapid and irregular growth of the skeleton or of the organs.¹ It is especially in the osseous system at the level of the extremities of the long bones that congestive excitation under ill-defined or little known influences takes place, which coincides with febrile disturbance, and may pass on into inflammation (osteomyelitis). The name “fever of growth”² is given to the systemic disturbance connected with such temporary stimulation. The phenomena vary in different cases. In many, on the occasion of some insignificant affection—slight sore throat or mild gastric fever—there is produced an accession of fever of great intensity, lasting twenty-four or thirty-six hours, manifestly connected with the local lesion. But in addition the patient is depressed out of proportion to the disease which he presents. During the attack of fever, and for two or three days afterwards, there exists, especially on pressure, a very decided sensibility at the level of the large epiphyses—femur, tibia, humerus—and if the individual has been measured before and after the attack, it will be found that he has increased in height by 1 or 1½ centimetres. In a second form the fever appears to constitute the whole disease, and the juxta-epiphysary determinations will be overlooked unless they are sought for (Bouilly). Analogous cases are mentioned by the older authors (Dechamp³). Bouchut cites the case of a child twenty-five months old, in which an increase of eight centimetres took place in six weeks. He had a remittent fever which was believed to be entirely connected with growth. It is highly probable, from these and similar cases, that in young subjects a febrile condition may arise from excessive action in the region where growth is in progress, that is, in the epiphysary zones.

¹ Regnier, *Maladies de Croissance*, Thèse de Paris, 1860.

² Bouilly, De la fièvre de Croissance, *Revue Mensuelle*, 1879, p. 707.

³ *Maladies de Croissance*, 1823.

REGENERATION OF BONE.

There can be no doubt the periosteum through its osteogenic layer is the chief agent in the reproduction of bone. Without it there cannot be any true re-formation. The part played by the marrow still remains unsettled. With the view of determining whether portions of transplanted marrow can give rise to the formation of true osseous tissue, experimental researches have been conducted by Gougon,¹ Bruns,² Maas,³ Vincent,⁴ and others. Bruns experimented on young dogs. A portion of the shaft of the femur or tibia was resected and marrow contained in this resected fragment removed in an unbroken cylinder. Portions of this cylinder were then inserted into fresh wounds on the breast or back of the same animal, either into subcutaneous fat or superficial part of muscular layer. The experiments demonstrated that bone marrow completely separated from its connection with bone and transplanted under the skin of the same animal at a remote part of the body may give rise to formation of bone and cartilage. The swelling at the seat of transplantation ossifies in part directly and in part by conversion of cartilage and osteoid tissue into hard bone. In each instance the osteogenetic function is due to the same elements, namely, to the osteoblasts which exist in the inner periosteal layer and are scattered amongst the elements of bone marrow, particularly in young animals. Other observers have failed to obtain similar results. It is evident that the ossification of medullary grafts is very uncertain, and some have not been able to secure it even after many trials (Ollier). The bone tissue by itself is almost inert. It derives its activity from the marrow which it contains or from the periosteum which covers it. Vincent,⁵ from a number of experiments undertaken with the view of ascertaining the part

¹ Thèse de Paris, 1866.

² *Archiv. f. Klin. Chir.*, bd. xxvi., hft. 3.

³ *Arch. f. Klin. Chir.*, 1877.

⁴ *Rev. de Chir.*, Nov., 1884.

⁵ See Abstract in *Medical Chronicle*, vol. i., Mar., 1885.

which the marrow takes in the production of new bone, came to the conclusions that the osteogenetic power is a property common to the three portions of a bone, and is derived from a common cellular factor, the osteoblasts, the number of which varies in the different parts of a bone, and that the activity of a bone is proportional to the age of the individual and the degree of irritation—pathological or experimental—to which it is subjected.

Bone Transplantation is a subject which has especially engaged the attention of Macewen and Poncet. The earlier attempts to graft bone were unsuccessful. In May, 1881, Macewen¹ published a paper on "Transplantation of Bone," and referred to a case where extensive bone grafting had been successfully carried out. The grafts were obtained from tibiæ operated on for anterior curvatures. The grafting was conducted on three different occasions, two wedges being implanted each time. The wedges, after division into minute fragments, were placed in a sulcus made between the humeral muscles of a boy who had lost the shaft of the humerus twelve months previously. By these numerous grafts the two epiphyses were united together by a firm shaft, and the utility of the member fully restored. Dr. Macewen adds that the best osseous grafts are obtained from young growing bone, and that preservation of the periosteum is not essential to the success of the graft. The instructions for grafting are given as follows: After removal of the bone, it ought to be divided into minute fragments about the size of a pea. When the grafting is about to be effected, the part into which the graft is to be placed must be prepared. The extremity of the bone to which the graft is to be attached ought to be refreshed, and the aperture between the muscles made of sufficient size to receive the osseous fragments without over distension. After all the bleeding has ceased, the part is ready for the reception of the graft. The

¹ *Proceedings of Royal Society*. See also article, "Bone Grafting," by Dr. Macewen, in Heath's *Practical Surgery*, vol. i., 1886, p. 617.

portion of bone to be transplanted ought then to be struck out of its normal position with a sharp chisel, and cut into small pieces, immediately thereafter placed in the sulcus prepared for it, and the soft parts closed over it. The whole operation to be conducted antiseptically. The limb to be fixed and kept at absolute rest. It is important to obtain healing without suppuration, otherwise some of the grafts may be thrown off. Poncet¹ (Lyon) concludes from his observations that certain conditions are indispensable in order that bone transplantation may succeed. And first the bone grafts must be small, in length from six to eight millimetres (*Greffes fragmentaire d'Ollier*), and three to four millimetres in breadth. They must contain periosteum, and ought to be implanted into parts where the granulating process is in progress, and where ossification is most active, that is, in the neighbourhood of the epiphysis. Whenever possible the bones of new-born children ought to be used; limbs amputated after injuries might furnish materials. Notwithstanding Macewen's successful case, Poncet agrees with Ollier that bone transplantation into connective tissue is useless. He maintains that it must be made during the time of the healing of the wound, when the inflammatory action has completely subsided, and the granulations present a healthy appearance, with little secretion of pus. The graft and the wound must be aseptic, and absolute immobility of the limb in a plaster apparatus is also indispensable.

Influence of Age on the Osseous System.—In order to appreciate correctly the effects of disease on the bones, it is important to consider the changes naturally induced in them by age. Speaking generally the density of a bone diminishes as age advances. The marrow encroaches more and more on the bone, the medullary cavities and Haversian canals extend their domain further and further, the osseous parietes which

¹ *Revue de Chirurgie*, Nov., 1886.

enclose them being constantly absorbed. The child has a small bone, slender and white; the adult has large vascular networks in its osseous framework; the aged has dilated lacunæ filled with a fatty marrow, except in the bones of the trunk, where in advanced life it remains relatively red. The atrophy assumes different forms according to the bone: in the flat bones, as the maxillæ, the diploe disappears, the osseous layers are thinner, and the entire bone diminished in volume. This takes place earlier in women than in men (Humphry¹), and is most marked in the upper jaw, owing to the greater sponginess of its alveolar process. In the long bones, the form and external volume appear preserved, the rarefaction being purely central, and the ends are first and most deeply affected. With the rarefaction changes in the interior there may be a continuance of the subperiosteal ossification producing an increase in the volume of the bone. The neck of the thigh bone is exceedingly prone to undergo the senile change, which renders this part of the skeleton peculiarly liable to fracture from slight causes. An exception to the general rule is often observed in the cranial vault. Owing to some unknown reason it is common to find in old people the cranium thickened and sclerosed. At other times the cranial changes correspond with those in the bones of the face, the whole cranium becoming lighter, thinner, and smaller. Humphry thinks the increase of thickness which is not uncommonly observed, and which chiefly affects the calvarial part of the skull, due to a deposit taking place in the interior of the brain case, owing to the lessened pressure there, and the consequent greater afflux of blood caused by the shrinking of the brain. The increase is usually most marked in the frontal region, which is in accordance with the fact that the shrinking is most evident in the frontal lobes of the brain (Humphry, *Treatise on the Skeleton*). The female skeleton is denser than that of

¹ Old age and changes incidental to it. Oration Med. Soc., London, May 4, 1885.

the male between birth and the end of adult life ; while in the aged, on the contrary, it falls below that of man, which accords with the common observation that old women are much older than old men of the same age, their ribs are more friable, and the heads of their femora are scooped out into larger cavities. Malgaigne estimates that in the aged there are twice as many fractures in females as in males, and Gurlt says they are seven times more common between eighty and ninety in females than in males. The ratio of the longitudinal growth of bone in the male and female is as 100 to 92, and the transverse growth showing the periosteal activity as 100 to 75. The age at which the senile changes occur varies ; there may be precocious senility and slow senility. Humphry¹ has seen the diaphyses of persons from eighty to ninety years which could not be distinguished from the normal state, while in other cases premature senility has been observed as early as forty-five years. With advancing years the cartilaginous portions of the skeleton become attenuated, resulting in a loss of height. Humphry, however, does not think they generally experience any other obvious change in ordinary healthy age. He has always found the costal cartilages soft in old people, and looks upon calcification of these cartilages as a degenerative rather than a normal senile change.

OSSEOUS CHANGES IN NERVOUS DISEASES (TROPIC LESIONS).

Arrest in the development of the bones of a limb affected with infantile paralysis was first described by Duchenne² (de Boulogne), afterwards by R. Volkmann (Halle). Bone atrophy bears no necessary proportion to the degree or extent of the muscular paralyses and wasting. Volkmann remarked in several instances that a transient infantile paralysis, which terminated a few days later in complete recovery, was nevertheless

¹ *Treatise on the Skeleton.*

² *De L'Electrisation Localisee*, 3rd edit., 1872, p. 400.

followed by trophic osseous lesions which continued through life. These cases show the direct influence of lesions of the central nervous system over nutrition of the bones. Arthropathy, connected with locomotor ataxy, is usually found in the knees, shoulders, and elbows; it may also occupy the hip joint. The information respecting it is still incomplete. One character is apparently constant, namely, the enormous wearing down which is exhibited in a very short space of time by the articular extremities, with no deposit of new bone (Charcot).¹ Spontaneous fractures also occur in ataxic patients, and are usually preceded by attacks of lancinating pain in the affected limb. The femur is often attacked. These fractures unite readily and firmly. Other trophic disorders arise from traumatic nerve lesions; periostitis is produced, often followed by necrosis (Paget).² These disorders are most apt to arise after injuries which produce neuritis, such, for example, as contusions, punctures, and incomplete sections of nerves.³ The arthropathies connected with lesions of the brain (hæmorrhage, softening tumours) bear a strong resemblance to those of spinal origin (Ross).⁴ The articular affection generally attacks the joints of the hand and foot, rarely the elbow or knee. Charcot describes the change as a true synovitis, with multiplication of the nucleus and fibrous elements of the articular serous membrane. In some cases the synovial sac is distended with a serous exudation, intermixed with white blood cells. The tendinous sheaths in the vicinity are occasionally inflamed at the same time.

Bone-changes in the Insane.—For a long period an idea has been entertained that the bones of insane persons are weak

¹ *Diseases of Nervous System*, New Sydenham Society, 1877, p. 97.

² *Med. Times and Gazette*, March 26, 1864.

³ *Surgery of American War*, Gunshot Wounds, p. 71; also *Archiv. gen. de Med.*, t. i., 1865, pp. 188, 191, 194.

⁴ *Diseases of the Nervous System*, vol. i., p. 225.

For further information respecting osseous changes in nervous diseases, see Wood, *Medical News*, 1884, Dec. 8; also Buzzard, *Lancet*, 1880, vol. i., 208.

when contrasted with those of healthy adults, and examples of fragile bones in lunatics have been from time to time placed on record. The subject is an important one, in view of fractures which unfortunately sometimes occur in asylums. Dr. Ormerod¹ investigated the nature of the osseous lesion in the ribs of lunatics, and describes the characteristic appearances to be "enlargement of the Haversian canals and a minutely granular appearance of certain districts, sometimes involving the entire Haversian systems." The process was described as absorption of the internal structures of the bones, the osseous tissue being replaced by an abnormal quantity of the fatty matter normally existing in its interior. Chemical analysis of the ribs of patients under asylum treatment (three out of five cases dying of phthisis, two of the cases being examples of general paralysis) was made by Drs. Rogers and Campbell Brown,² and the result given "that the ratio of organic constituents to earthy is much greater, while the ratio of lime to phosphoric acid is distinctly less in the ribs of paralytics than in those of healthy adults, the composition of bones in cases of paralysis approaches that observed in osteomalacia." Dr. Wigglesworth³ contributed a most valuable paper on "Bone Degeneration in the Insane," the result of prolonged microscopical investigations. He formulated the following conclusions, which may be regarded as embodying the extent of our knowledge on the subject up to the present time.

1. The ribs of lunatics are perfectly healthy in a minority of cases.

2. The majority present some slight degree of change, which consists in a slight thinning of the external layer of compact bone and slight enlargement of the Haversian canals, but that these changes are in general merely trivial, and to be

¹ *St. Bartholomew's Hospital Reports*, 1871.

² *Liverpool Medical and Surgical Reports*, 1870.

³ *British Medical Journal*, vol. 2, 1883, p. 628. Paper read in the section of Psychology at the Liverpool meeting of the British Medical Association.

correlated with the general failure of nutrition so common in insanity, or with the presence of a wasting disease such as phthisis, or with the advent of old age, or it may be with a combination of all of these.

3. In a minority of cases, provisionally estimated as ten per cent, clear and precise lesions are found, produced by considerable internal absorption, which renders the bone very porous and brittle, and brings it under the category of the condition known as osteoporosis.

A condition not unlike osteomalacia is also observed in which deformities of various kinds occur. The nature of the osseous lesions in the insane, therefore, is twofold: in the one, the bones are soft and yielding; in the other, brittle and liable to fracture from slight and insufficient causes.

CHAPTER II.

HYPERTROPHY AND ATROPHY OF BONE.

Hypertrophy, a frequent consequence of inflammation in bone, especially when it runs a chronic course, manifests itself either by a condensation in structure, an augmentation in size (*fig. 1*), or an increase in length, and occasionally all these conditions may be found united. An instance of this kind was observed in a man who, during his youth, had suffered from osteo-periostitis of the tibia, followed by the formation of abscesses and the expulsion of several pieces of necrosed bone. Twelve years later certain symptoms developed indicating suppuration within the thickened shaft of the tibia, which were relieved by the trephine. The tibia on the diseased side had increased in length as well as in thickness, and exceeded the healthy one by an inch. Circumstances subsequently arose which required amputation of the limb, and a section of the tibia showed sclerosis with obliteration of the medullary cavity in the greater portion of its extent. Another example of an increase in the length and size of the tibia occurred in a boy who had sustained a Pott's fracture eleven years previously. Union of the fibula had taken place while the foot was still displaced outwards. The pressure being removed from the lower end of the tibia led to an increase in its length, and on removing the internal malleolus to correct the malposition, the hypertrophy was found to consist of spongy osseous tissue (spongy hypertrophy). Another instance of an increase in length is found in genu valgum, where, according to Macewen, the internal condyle of the femur is sometimes elongated to the extent of an inch. When inflammation attacks a long

bone such as the tibia or femur before the junction of the epiphyses takes place, the limb on the affected side may exceed its fellow in length; and this may not only induce lameness, but be a source of trouble in explaining obscure symptoms, unless the history of the previous elongation is obtained.

FIG. 1.



FIG. 1.—Hypertrophy, with sclerosis of the femur, the result of prolonged osteitis; the bone is converted into a solid cylinder (*O. C. Museum*).

Stanley¹ relates several remarkable instances of hypertrophy in the bones of the leg, all of them occurring in scrofulous subjects. A boy, aged fourteen years, with a marked scrofulous constitution, was admitted into St. Bartholomew's Hospital. Four years previously an abscess had formed in the thigh, and on the cessation of the discharge from it the tibia in the opposite leg began to enlarge. The tibia was not only increased in thickness, but also in length to the extent of an inch and a half. The periosteum of the hypertrophied bone was much thickened. To relieve himself from the inconvenience of the unequal length of his legs, he had acquired the habit of walking with his knees slightly flexed and his foot twisted outwards. Should the increase in length occur in the tibia while the fibula remains unaffected, the diseased bone will become curved anteriorly. Hitherto hypertrophy as the result of chronic inflammation has been principally mentioned. It may also ensue from an increase in the normal nutrition occasioned by an excess of function (*fig. 2, b*). It sometimes happens in acute necrosis involving the tibia that the amount of new bone formed is very scanty, so that when the sequestrum is removed the bone deposit gives little or no support to the limb. Under these circumstances, if the limb be used, the fibula may undergo hypertrophy,² which is most marked opposite the deficiency in the tibia. Under the term non-syphilitic diffuse periostitis, Le Dentu³ refers to a peculiar hypertrophy of the bones of the face and skull. The affection most frequently attacks first the bones of the face, especially the superior maxilla, and extends to the skull. It rarely commences in the inferior maxilla. In all known cases save one the disease developed in youths or in quite young people. Its progress is slow, and it generally lasts for several years. Though usually

¹ *Diseases of the Bones*, London, 1849.

² Markoe, *Diseases of Bones*, London, 1872.

³ *Revue Mensuelle de Med.*, Nov. 10, 1879.

painless, it may occasion suffering by giving rise to compression of nerve trunks. The gravest and most common consequences of the disease are difficulty of alimentation and of articulation, obliteration of the nasal fossæ, abolition of hearing, blindness accompanied by exophthalmia and suppurative destruction of the eyeball, also various cerebral symp-

FIG. 2. ✓

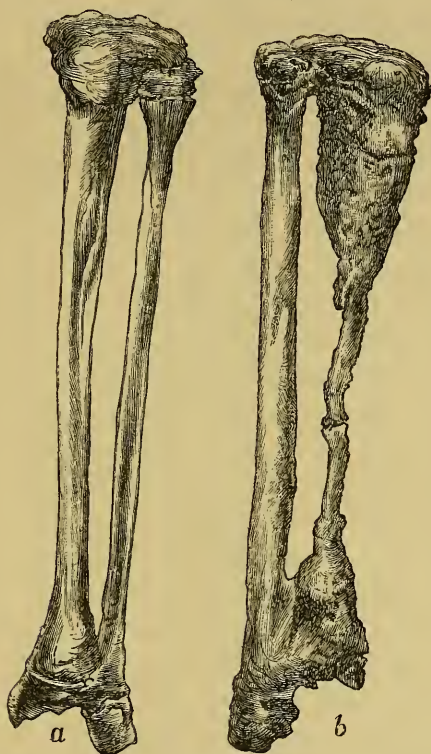


FIG. 2.—*a*, Normal tibia and fibula. *b*, Compensatory hypertrophy of fibula (*Markoe*).

toms. Death is generally caused by defective nutrition and cerebral disturbance (meningeal apoplexy). This description closely resembles that given in Stanley's work, and no doubt similar conditions are referred to. No method of treatment seems to have any influence in preventing the slow advance-

ment of the disease. Removal of the diseased part while one bone only is invaded is recommended by Le Dentu. Stanley advises the same treatment when the disease is manifestly increasing, and thinks that when the propriety of an operation is considered the difficulty consists in determining the exact boundaries between the healthy and the diseased bone, since the extent of the latter is not indicated by any morbid change in the soft parts covering it.¹ The rule in such cases should be to remove the whole of the diseased part. The disease described by Le Dentu bears a close resemblance to that condition which is known as "Leontiasis ossea" (Virchow), generally met with as an overgrowth limited to one or two bones of the skull or face or to parts of a bone; it may be found associated with a similar condition extending to other bones of the skeleton.²

Hyperostosis³ is a term sometimes employed to indicate general in contradistinction to local forms of hypertrophy. In specimens examined by Dr. Goodhart and obtained from a man sixty years of age, where all the bones of the body were enlarged, the periosteum appeared natural, but the bone, although firm and heavy, was much softer than normal bone, and presented a pink appearance throughout. The bones examined were the ribs, thigh bones, those of the cranium and of the pelvis, and all were found affected, but apparently not those of the face. The left clavicle, two and a half inches in circumference, appeared uniform on section, with scarcely any medullary canal and no cancellous tissue. The femur weighed two pounds fourteen ounces and was from six inches and a half to eight inches and a half in circumference. The pelvis partook of the form usual in rickets. Examined with the microscope the Haversian canals in the diseased bone

¹ *Diseases of the Bones*, London, 1849, p. 4.

² Wilks and Moxon, *Lectures on Pathological Anatomy*, p. II.

³ Some pathologists reserve the name hyperostosis for that condition of bone in which it is thickened in its whole length and throughout its entire circumference.

PLATE I. ✓



were found to be enlarged and irregular in shape. The disease had existed for twelve years, and the patient died of asphyxia, owing to fixation of the chest from disease of the ribs. Nothing is known in regard to the causation of those forms of hypertrophy unconnected with inflammation.

The curvature of hypertrophied bones is liable to be mistaken for that which results from rickets and osteomalacia. In hypertrophic elongation of the tibia the bone curves anteriorly, while in rickets it is usually bowed outwards and the bone is shorter than natural. Osteomalacia, as we shall see later on, is a disease of adult life in which there exists a general deformity and weakness of the bones, which will distinguish it from hypertrophy.

Treatment.—Once a bone becomes hypertrophied, no remedy can have any effect in diminishing its size. The surgeon can, however, do a great deal to relieve the patient from the inconveniences which may arise from a difference in the length of the limbs by recommending him to wear on the healthy limb a high-heeled shoe with a thick sole. Iodide of potassium may be useful where there is any suspicion of syphilis being the cause of the hypertrophy. Occasionally symptoms resembling those arising from bone abscess may depend upon sclerosis of the osseous tissue. In these cases linear osteotomy or removal of a circle of bone with the trephine may be attended with a beneficial result. A boy sixteen years of age, who two years previously had suffered from acute osteomyelitis of the tibia, which subsided after trephining the bone, came again under observation with symptoms closely resembling those associated with abscess. A very tender spot could be detected a little below the centre of the shin, and on pressure in this situation the pain was much aggravated. A circle of dense bone of ivory hardness was removed with the trephine, afterwards some more bone was chiselled away until the medullary cavity was reached. The pain completely subsided.

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ATROPHY OF BONE.

Two distinct forms of bone atrophy have to be considered; in one there is wasting of a bone which has reached its full development, while in the other there is an interruption in its growth. Familiar examples of senile atrophy are those which occur in the neck of the femur and in the alveolar process of the lower jaw, subsequent to the dropping out of the teeth. Disuse is followed by atrophic changes in bone; thus we find atrophy of the femur in ankylosis of the hip joint, and of the humerus in ankylosis of the shoulder joint. The possibility of atrophy accompanying ankylosis should always be borne in mind, otherwise a fracture may be easily produced in a bone which has remained inactive for a considerable period. Any attempt to correct an ankylosis should therefore always be carried out with due precautions. In a paralysed limb, besides a want of action, there is a withdrawal of nerve power, hence we have gradual atrophy in the bones of a limb suffering from paralysis.

Interruption to the proper supply of blood, owing to the nutrient artery being injured, is another cause of atrophy, and may lead to non-union in a bone. Curling¹ observed that in the portion of a fractured bone deprived of blood from the medullary artery, the walls became thin and the cells widened; such will be the condition of the lower part of the femur or tibia fractured below the entrance of the medullary canal, while in the humerus the upper portion becomes atrophied when the fracture has occurred above the entrance of the medullary artery. Tumours of various kinds may also produce atrophy from pressure during their growth. As examples, we may mention tumours growing within the antrum and aneurism of the aorta. A growth in the antrum, while it expands the walls of that cavity, will also thin them

¹ Curling on atrophy of bone, *Med. Chir. Trans.*, vol. xx.

until they finally disappear. Again, aneurism of the aorta will, by constant pressure against the vertebral column, erode the bones until a large cavity is formed, and in some cases even the spinal canal is laid open.

Arrest of growth may attend atrophy of bone in early life; thus the bones of a joint which has been anchylosed since childhood are found atrophied in texture and of smaller size, owing to their not having grown with the rest of the body. Rickets in any of the bones of the limb is also very commonly accompanied by arrest of growth, especially in length. Humphry observes that in rickety subjects the femur and humerus are about one-fourth shorter than the corresponding bones in healthy individuals of the same age. Arrest of growth may also result from injury to the epiphyses in children. In infantile paralysis the bones participate in the general smallness of the paralysed limb. A peculiar form of atrophy sometimes follows a blow or fall on the trochanter major (*fig. 3*). It may lead to considerable diminution in the length of the limb and to serious inconvenience in walking. Its importance from a medico-legal point of view should not be forgotten. This remarkable change was observed in a patient,¹ fifteen years of age, admitted into the Manchester Infirmary nine months after a fall on the hip. The injury was not severe, for immediately afterwards he was able to walk home a distance of more than a mile. The limb gradually shortened until there was a difference of two inches between it and the sound one. While the change was progressing the patient had experienced a slight aching pain about the hip, so that in all probability the morbid action which leads to atrophic changes bears a close resemblance to, if it is not identical with, rarefying osteitis. It appears that blows or falls on the hip can disturb the circulation in the neck of the thigh bone to such a degree as to

¹ Reported in *British Med. Journal*, vol. i., 1882, p. 227.

determine changes which result in shortening of the neck and considerable deformity of the limb. The injury, in other words, induces premature senile changes. Either sex may experience this result and no peculiarity of constitution is to be detected as constantly present in these cases ; blows on other bones or joints are not followed by such a phenomenon ; early or late in life atrophy may succeed the violence ; the shortening may increase with greater or less speed, and the gradual,

FIG. 3. ✓

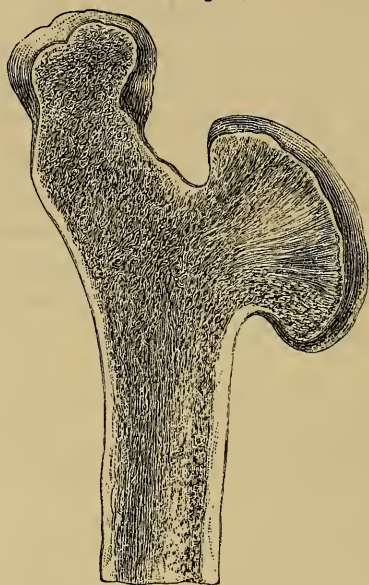


FIG. 3.—Atrophy from interstitial absorption of the neck of the femur (*Gulliver*).

insidious, and, in some instances, almost complete removal of the cervix femoris, is accomplished without any appreciable signs of inflammation. The commencement of the shortening may date from the time of the accident, or occur some weeks or months subsequently.¹ Bell,² in 1825, attended a lady

¹ *Surgical and Pathological Observations*, by E. Canton, Lond., 1855, p. 33-34.

² *Diseases of the Bones*, B. Bell, 1828, p. 198.

thirty-five years of age, who could walk with assistance a few days after an accident. In this case the limb was shortened to the extent of an inch, in the course of ten months after the receipt of the injury. It would be well to warn a patient (especially an aged one) who has sustained an injury to the hip, that structural alteration of the neck of the thigh bone is within the range of possibility; otherwise the surgeon at some future time may be blamed for having overlooked a supposed fracture or dislocation.

Treatment.—Little can be said on the treatment of atrophy of bone. Should it occur in the lower extremity and lead to inequality in the length of the limbs, means must be adopted to remedy the lameness and to prevent lateral curvature of the spine. The patient should be advised to wear a high-heeled boot on the diseased side. Occasionally shortening of the tibia may induce a permanent elevation of the heel which necessitates division of the tendo achilles; this, combined with the employment of a suitable boot, will relieve the condition.

Adipose osteoporosis, or eccentric atrophy of the bones, is seen in the epiphysial extremities of the long bones and in the short bones. It consists in a rarefaction of the osseous tissue with the production of a large quantity of fat cells in the medullary spaces and Haversian canals. The trabeculæ of the spongy texture thin and finally disappear, while the compact structure becomes thinner and more porous. The bone is then reduced to a light, fragile shell, pierced with numerous vascular holes (Cornil and Ranvier). Whenever joints are affected with chronic disease, or have been fixed for some length of time, this condition of osteoporosis is prone to exist.

Senile Osteoporosis or Senile Osteomalacia.—In this affection there is also rarefaction of the osseous tissue owing to enlargement of the medullary spaces; but, unlike the fatty osteoporosis, the marrow in the dilated spaces, instead of being fatty, is more closely allied to the foetal medulla,

and the changes which it undergoes are similar to those observed in ordinary osteomalacia. Senile osteoporosis most frequently attacks the ribs and vertebral column. The ribs break easily from slight causes, and perfect consolidation is effected by the ossification of the cartilaginous callus (Cornil and Ranvier). The vertebral column is the seat of a posterior curvature.

Fragilitas ossium, a condition of the osseous system characterised by an unusual tendency to fracture from trivial causes. It is often merely a symptom, which may exist in different diseases of bone, in rickets, osteomalacia, atrophy of bone, &c. Sometimes we meet with cases in which the fragility is not associated with any appreciable morbid lesion in the bones: these are described as idiopathic forms of *fragilitas ossium*, and may be found in otherwise healthy individuals. The predisposition appears in some instances to have been inherited, and to have affected several members of the same family. Stanley relates a case in which thirty-one fractures had occurred in a girl fourteen years of age, the first at the age of three. One leg had been broken nine times. There is an important point in connection with these fractures: they readily unite. Examples to the contrary are, however, not wanting. Thus Blanchard¹ mentions a boy aged twelve years who had sustained forty-one fractures, all of them uniting very slowly, and some requiring two and three years before consolidation was complete. The bones become fragile in certain diseases of the nervous system (locomotor ataxy). The condition is also induced by syphilis and cancer, from diffuse gummatous or cancerous infiltration.²

¹ *Chicago Medical Journal*, 1876, p. 7.

² Neumann, Spontane Fractur des Humerus in Folge von Osteomyelitis gummosa, *Wien. Med. Bl.*, 1882, p. 1566.

CHAPTER III.

INFLAMMATION OF BONE.

The component parts of a bone—the periosteum, proper osseous tissue, and medulla—are structurally so closely associated together that they are often attacked by the same morbid process, although usually in different degrees. Clinically, therefore, periostitis, osteitis, and osteomyelitis are presented to us almost always in association. French writers¹ employ the term osteitis or ostitis in its widest acceptance, to include the three diseases usually described separately. They consider the distinction between periostitis, osteitis, and osteomyelitis as more interesting clinically than pathologically. They regard periostitis as a superficial osteitis, and histologically considered osteitis is characterised by phenomena similar to those which occur in the medullary canal, so that every osteitis is an osteomyelitis. When inflammation attacks a bone it exhibits many variations clearly attributable to the character of the tissue in which the morbid process takes place, and not to any peculiarity in the process itself, which is in its essential nature the same here as in the soft parts. The consequences produced by inflammation in bone bear a strong resemblance to those induced in the soft structures, due allowance being made for the difference in structure. The process may commence either in the periosteum or the medulla, very rarely in the osseous tissue proper. Experience seems to show that the medulla is a very frequent starting point of the traumatic inflammatory disorders of the bone.

¹ *Pathol. Histology*, Cornil and Ranvier, English Trans., 1882.

Periostitis, or inflammation of the periosteum, presents two varieties : 1. Circumscribed ; 2. Acute and diffuse.

1. *Circumscribed*¹ *Periostitis* (*Syn. Node*).—*Symptoms*.—Generally a chronic affection marked by pain, usually worse at night, often severe when patient becomes warm in bed ; local tenderness on pressure, and an ill-defined swelling of a rounded or elongated shape. It is rare for the inflammation to be strictly limited to the periosteum, the compact tissue in immediate relation with the inflamed periosteum being generally implicated, or it may extend even beyond the osseous tissue proper and involve the medulla, producing an osteomyelitis.

Causes.—Circumscribed periostitis may be of traumatic origin, or it may arise from constitutional causes, such as scrofula, syphilis, rheumatism, or gout. The disease may also be secondary, and produced by extension of the inflammatory process from the medullary tissue or from the superficial soft structures. The cause of a circumscribed periostitis will modify its symptoms very considerably. When of a rheumatic origin the pain will change from place to place, the joints are usually implicated, and frequently other symptoms indicative of rheumatism are present (sour perspirations, abundance of lithates in the urine). The benefit often derived from large doses of salicylate of soda, even when the disease has been of long duration, will also show the rheumatic character of the inflammation. Periosteal lesions of rheumatic origin may be confined to the fibrous layer of the membrane without any affection of the subjacent bone. This, however, is by no means the rule, for the two layers of the periosteum are so intimately united, and the nutrition of the membrane so closely connected with that of the bone which it covers, that a periostitis very easily becomes a peri-osteomyelitis. It follows that a rheumatic inflammation of the external layer of the

¹ This class includes the two varieties usually described separately, viz., chronic, and simple acute periostitis.

PLATE 2. ✓



periosteum may easily spread to the deeper layer with irritation of the osteogenetic layer and formation of new osseous tissue (hyperostosis). Periostitis occurring near a joint is apt to extend to the neighbouring articulation, the synovial membrane sharing in the morbid process. Again, inflammation within a joint may extend to the periosteum along the fibro-synovial structures.

Pathology.—During the earlier stages of the inflammation the periosteum is swollen from dilatation of the vessels and exudation into its substance and beneath it, producing a swelling sometimes called a node. The thickened periosteum is readily detached from the underlying bone, which not unfrequently presents evidences of commencing inflammation. The subsequent fate of the inflammatory transudation will vary. It may be gradually and completely reabsorbed, the periosteum regaining its normal state (resolution), or it may ossify (*plates* 2 and 3), producing a permanent thickening of the shaft, or, lastly, the morbid process, usually with local and general evidences of fever, terminates in the formation of pus between the periosteum and bone, leading in all probability to superficial necrosis. When the periostitis is due to syphilis the resulting node is tender, circumscribed, with a rounded outline, and its termination is determined by the stage of the disease at which it appears. If during the tertiary stage, its tendency is to break down and to produce superficial ulceration or necrosis (see syphilis of bone). During the earlier stages of syphilis the tendency will be to ossification of the exuded products and thickening of the bone. As rheumatism is a disease which has little or no tendency to suppuration, the periosteal inflammation which arises under its influence rarely passes beyond the first stage—that of serous exudation.

Diagnosis.—It is possible to mistake circumscribed periostitis for a periosteal growth; the history of the affection, together with its progress, will render material assistance in discriminating between the two conditions.

Treatment.—Periostitis originating in an injury rarely demands any special care. The treatment indispensable for the cure of the injury sustained by the soft structures overlying the bone will generally suffice to relieve the inflamed periosteum. It will include the observance of rest, together with the application of cold (lead and spirit lotion), and if the pain is severe, much benefit will accrue from the local abstraction of blood by means of leeches. Light articles of food should constitute the diet, and it is essential to secure a free action of the bowels. The internal administration of opium may be required for the alleviation of the pain. Should the disease resist the means suggested, and the inflammation terminate in the formation of a circumscribed abscess, free incision through the soft structures, including the periosteum, must be made. Division of the swollen periosteum may also be adopted for relieving the increasing severity of the pain, due to the inflammatory products being confined beneath a tense and resisting membrane. Take away the tension and the pain will subside, and the chances of the bone being implicated in the morbid process will be decidedly lessened.

There appears to be an unintelligible objection on the part of some surgeons to the division of an inflamed periosteum. My own opinion is that the risks of delay are very decided and real, and the risk of incising almost nil. The rule should be if traumatic periostitis does not yield to the simpler methods of treatment, and the pain is severe, to divide the tissues overlying and including the inflamed and swollen periosteum. Very frequently a hardness remains after the subacute or chronic attack subsides. In such cases the application of iodine or of blisters will prove beneficial. In periosteal inflammation arising from a constitutional vice the treatment will depend on the cause. Both the rheumatic and syphilitic varieties are beneficially influenced by the administration of iodide of potassium, while that form of the disease associated with scrofula is best treated by the use of cod liver oil in combination with the syrup of the iodide of iron.

PLATE. 3. V



2. *Acute periosteal abscess* or diffuse periostitis, often a very serious disease, attacking young subjects, especially those of the male sex. Chassaignac¹ mentions thirty-three cases which he collected: of these, four occurred before the age of ten, fifteen between ten and eighteen, and four between the ages of eighteen and thirty-six. Boys, therefore, during the growing period of life, appear peculiarly liable to this disease, and there can be no doubt the important physiological changes taking place on the under surface of the periosteum while growth is proceeding constitute a decided predisposition to acute inflammatory disorders. A scrofulous diathesis, and exhaustion of the system from whatever cause arising, produce an undoubted tendency to the disease, its immediate exciting cause not unfrequently being a slight injury. It generally attacks one of the long bones, especially those of the lower extremity—femur or tibia. The disease is generally confined to the diaphyses, the epiphyses and articulations contiguous to the affected bone almost always preserving their integrity. There may be, however, some effusion into the synovial sac due to irritation transmitted from the inflamed periosteum. The fluid usually disappears when the periosteal inflammation subsides. Suppurative inflammation of the periosteum may and frequently does affect the medullary membrane and osseous tissue, and the character of the disease is thereby very seriously aggravated; extensive necrosis will inevitably result, and the patient only too frequently succumbs to the grave constitutional disturbance often associated with pyæmia.

A case of acute periosteal abscess unaccompanied by suppurative inflammation of the medullary tissue occurred in a girl eight years of age, whom I saw with Dr. Rhodes, of Didsbury. There were no strumous antecedents, and no history of injury. The disease attacked the femur in its lower half. It was associated with serious disturbance of the system and high fever (T. 104°). A diffused swelling appeared and increased very rapidly; the

¹ *Traité Pratique de la Suppuration*, t. i., p. 413.

skin was red and slightly œdematous. An incision evacuated a very large quantity of pus mixed with altered blood, giving it a brownish colouration. The fluid had collected between the periosteum and bone, and several inches of the latter were exposed and naked. The acute symptoms quickly subsided after the escape of pus, the fever abated, and the separated periosteum again became adherent to the bone, the cure being effected without any exfoliation. Such a termination would scarcely have been possible had the medullary membrane participated to any extent in the inflammatory process.

Symptoms.—Pain is generally the first symptom, preceding all the others, even the fever (Chassaignac). It is severe, deep seated, liable to nocturnal exacerbations, and has been compared to that accompanying a whitlow. These characteristics serve to distinguish it from the pain connected with diffuse cellulitis, a condition not unlikely to be mistaken for acute periosteal abscess. The pain is soon followed by a swelling, at first confined to the bone attacked, afterwards becoming more diffuse as the suppurative inflammation involves the superficial soft structures. Severe fever, with its attendant phenomena and very decided derangement of the general health, accompanies or precedes the swelling.

Pathology.—Periosteum thickened, inflamed, and pus quickly collects between it and the bone. The inevitable result of this will be destruction of the nutrient vessels which enter the bone from the periosteum, seriously compromising the life of the superficial layers, and frequently ending in necrosis. Occasionally the periosteum ulcerates, thereby allowing the pus to escape, causing inflammation and suppuration in the cellular tissue. Collections of pus form and give way externally; at the bottom of the resulting sinuses bare bone can generally be detected. The suppurative inflammation may be confined to a portion of a diaphysis, or the whole of the shaft may be involved. Acute osteomyelitis usually accompanies the more severe forms of the disease.

ACUTE SUPPURATIVE PERIOSTITIS OF THE RADIUS; SECONDARY OSTEO-MYELITIS; NECROSIS; SEQUESTROTOMY; RECOVERY.

Case 1.—John N., aged thirteen, admitted into the Manchester Infirmary, June 15th, 1886. He is a healthy-looking lad, and has not suffered from any serious illness previously. Father died at forty-four years of age; cause not known. One sister died from a bone disease when eighteen years old. Mother, one brother, and a sister living and healthy. On June 7th, without any known cause, his right forearm began to swell from wrist to elbow; he also felt a severe pain shooting up the arm. The pain and swelling appeared simultaneously, and, as they increased, he was brought for advice. On admission the whole forearm was very much swollen, being double its normal size. The swelling tense and brawny, but not œdematous; no fluctuation, and no pain produced on pressure. A good deal of effusion into both elbow and wrist joints, with pain on any attempt at movement. He was put under chloroform, and two incisions made down to the radius on the posterior aspect of the limb, each incision being about two inches long. A large quantity of very thick pus escaped, and nearly the whole of the diaphysis of the radius could be felt denuded of periosteum; drainage tubes were inserted and the wounds dressed with iodoform and wood-wool. Patient began to improve soon after the operation, the pain at once ceased, and the temperature, which previously had reached 102° , fell to normal in three days. The wounds were dressed daily and progressed favourably. He was ordered iron and quinine, and rapidly improved in general health. The improvement being very marked, he was allowed to get up on the fifth day. Two days later the fever again returned, and a fluctuating swelling appeared in the soft parts over the head of the radius, the lower of the two sinuses on the back of the forearm had healed, the upper one was still discharging. As the temperature continued to rise, chloroform was administered and incisions made into the fresh swelling. About an ounce of pus escaped; the abscess was confined to the soft parts, but the head of the radius was preternaturally movable from inflammatory softening of the orbicular ligament. The cavity was syringed out with an antiseptic fluid and a drainage tube inserted. The sinus which directly communicated with the necrosed bone was explored at the same time, but as the dead portion had not yet separated, no attempt was made to remove it. After an interval of about a month, during which time the temperature had been very irregular, never reaching higher than 103° , generally keeping about 100° , the sinuses were joined together, and a sequestrum consisting of the entire thickness of the radius and about two inches in length was removed, after which the wounds quickly closed. A free formation of periosteal new growth and considerable thickening of the soft parts remain. The movements of the elbow and wrist joints have been completely restored, but supination can only be very imperfectly performed.

Diagnosis.—Acute periosteal abscess has to be diagnosed from acute diffuse cellulitis and acute osteomyelitis. The age of the patient, character of the pain, usually limited to the diseased bone, together with the effect produced by exploratory incisions, will help in discriminating it from the former; while

the course of the disease and the insufficiency of incisions through the periosteum alone are points to be remembered in distinguishing it from the latter.

Terminations.—Acute periosteal abscess, when of limited extent, may subside after the escape of pus, as in the case already mentioned, the irritation being generally followed by the exuberant production of new bone. Usually there is more or less necrosis, and the cure is delayed until the dead bone separates and is expelled or removed. If the suppurative inflammation is very extensive, and especially if it is accompanied or followed by acute suppurative osteomyelitis, large portions or even the entire diaphysis of a bone will die, and the patient not infrequently succumbs to the purulent infection, or sinks from exhaustion due to prolonged suppuration, which lasts as long as the necrosed shaft remains. At the early stages death may supervene from the intensity of the constitutional disturbance or from septicæmia. Recovery may take place after a tedious process of separation and removal of dead bone.

Prognosis will largely depend on the intensity of the disease and on the amount of medullary tissue implicated in the morbid action. If the disease is limited to the periosteum, and an early incision evacuates the products of inflammation, a cure may very possibly be effected without any exfoliation of bone. This is more likely to happen when the disease occurs in a young subject and treatment is adopted early. The periosteum may be stripped from the bone to a considerable extent, and raised by a subperiosteal collection of pus. When the latter is evacuated and healing occurs without any necrosis, the inflamed membrane again becomes adherent to the bone. In some cases the intensity of the inflammatory process destroys the vitality of the periosteum, and a new membrane is formed from the circumference of the remaining periosteum, or at the expense of the deep cellular and muscular layers in relation to the bone;¹ while in others, especially when

¹ *Nouveau Dict. de Med. et de Chir.*, Jaccoud, 1877, Art., Os.

the subperiosteal abscess is followed by necrosis, the granulations springing from the portion of living bone, after the sequestrum has been ejected or extracted, are converted into a pyogenic membrane which gradually becomes fibrous and replaces the periosteum. Whenever acute suppuration involves the medullary tissue in addition to the periosteum, the prognosis must always be guarded — often grave and frequently unfavourable.

Treatment, to be of any substantial benefit, must be resorted to early. Tincture of iodine freely painted over the inflamed and painful part is extolled by Billroth; other surgeons employ a blister covered by a flax seed poultice. It is scarcely necessary to say that the limb is to be kept absolutely at rest, as the pain causes the patient intuitively to seek repose. Incisions are to be employed early and made freely; infinite harm might be done by counselling delay until the suppuration declares itself unequivocally. While this is taking place the periosteum is being separated from the bone to such an extent as to threaten, if not destroy, its vitality. The only hope of preventing necrosis which we possess is by timely and free evacuation of the pus. I should certainly recommend prompt incisions as soon as the nature of the disease is recognised, for it is characteristic of the affection that suppuration quickly follows the onset of the inflammation, and nothing short of incising the periosteum can be relied upon to accomplish any good. I would even go further and say that in doubtful cases where the symptoms are obscure and not decided, but where localised pain and tenderness exist, an exploratory puncture with a tenotomy knife is a proceeding which cannot possibly be followed by any harm, and may be successful in at once giving relief. To wait until the presence of matter is indicated by fluctuation is to prolong the patient's suffering and clearly to diminish his chances of recovery without necrosis. To quote an illustrative case, a lad ten years of age was suddenly attacked with symptoms which at first seemed to indicate

rheumatic fever. The chief pain was in the left femur, especially in the vicinity of the knee joint, and soon a painful swelling appeared in this situation. An incision gave exit to a large quantity of pus, quickly followed by a subsidence of the fever and relief from pain. Fully three inches of the lower and outer part of the femur was denuded of periosteum, still there was no death of bone. The abscess cavity was freely cleansed with disinfectants, the discharge soon diminished and ceased within a month. The patient was examined twelve months afterwards, and with the exception of the scar, no difference between the two thighs could be detected, any thickening that may have existed having completely disappeared. The satisfactory result in this case may fairly be attributed to the timely evacuation of the pus.

When the bone dies, as the result of acute periosteal suppuration, the sequestrum must be removed as soon as practicable, the patient's strength meanwhile being maintained by general tonics and a nutritious diet. If acute suppurative osteomyelitis accompanies the subperiosteal abscess, and the bone consequently quickly dies, it may be deemed necessary to remove the entire diaphysis. This has been successfully done by many surgeons, but the ultimate results are not such as would warrant us in adopting this procedure without very careful and deliberate consideration. This question will be discussed at greater length when we come to examine the treatment of that most important disease of bone, usually designated acute suppurative osteomyelitis.

PERIOSTITIS¹ IN ITS RELATION TO THE SPECIFIC FEVERS, ESPECIALLY TYPHOID (EXANTHEMATOUS NECROSIS).

Several writers have alluded to the possibility of the occurrence of periostitis during convalescence from typhoid and

¹ Mr. Salter, in a paper published in the *Guy's Hospital Reports*, 1858, 3rd series, vol. iv., was one of the first in this country to draw attention to cases of bone disease occurring in the jaws after the eruptive fevers.

other fevers. Droin¹ says that osteo-periostitis sometimes supervenes after severe fevers, such as typhoid, scarlatina, and measles. Murchison² mentions a case of necrosis of the tibia, and another of the temporal bone, in patients convalescing from typhoid, and refers to a third where an affection of the upper end of the femur occurred after the same disease. All the patients were young children excepting one, a girl aged sixteen. Dr. Keen,³ of Philadelphia, regards osseous lesions as unfrequent but important consequences of typhoid fever. In a number of cases collected by him continued fevers were complicated sixty-nine times with diseases of bone, fifty times with necrosis, twelve times with caries, three times with periostitis, and in four the diagnosis was doubtful. No region appears to be exempt from the disease. The head was attacked twenty-two times, trunk seven times, the upper extremities six times, and the lower forty-two times. According to Paget⁴ the tibia most often suffers; the complication being met with also in the femur, fibula, ulna, radius, scapula, and parietal bones. Sometimes both tibiæ have been affected, the disease being symmetrically placed in the lower parts of the shafts. The affection usually appears during convalescence, that is, after five or six weeks of the disease. It may declare itself earlier, or its appearance may be delayed for many weeks or even months (Keen). Then it arises spontaneously, or a slight injury determines the situation of the disease. It is usually circumscribed, rarely more than two or three inches in extent, and the symptoms take a subacute or chronic course, very rarely partaking of the nature of acute necrosis. The periosteum is infiltrated and swollen, and the part tender on pressure, and this condition may persist for some time, then disappearing without any death of bone. At other times pus forms under-

¹ Thèse de Paris, 1868.

² *Continued Fevers*, 2nd edit., Lond., 1873, p. 582.

³ *Surgical Complications and Sequels of Continued Fevers*, Phil., 1877.

⁴ On some of the sequels of typhoid fever, *St. Barth. Hosp. Reports*, vol. xii., 1876, p. I.

neath the periosteum, which is itself much thickened. The matter may disappear by absorption, or be discharged externally. Should necrosis follow the periosteal inflammation, the amount of bone that dies is, as a rule, not very considerable, and its separation is effected in the usual manner.

It is very important to remember how very easy it is to confound typhoid fever with acute inflammation of bone. The febrile disturbance associated with the latter affection may be erroneously considered as indicating the presence of one of the continued fevers, the resulting necrosis being then attributed to the wrong cause. I do not wish to state that the specific fevers do not constitute a genuine predisposing cause of certain bone affections, but on several occasions I have known cases sent into hospital as typhus or typhoid, where the disease has subsequently proved to be acute osteomyelitis. Excessive pain in any part of the body (lower limbs in particular), combined with acute fever, should, therefore, always make us at any rate examine the part with a view of determining the presence or absence of periostitis, and this is the more imperative when the symptoms develop in young subjects.

In addition to the situations already mentioned, the sequela may appear in connection with the ribs; and here, according to Paget, it differs from the affection as seen in the long bones in that it never terminates in necrosis. This view is borne out by a case published by Jackson¹ of periostitis of the rib following typhoid fever in a man aged forty-two years. The sequela developed about seven months and a half after a severe attack of typhoid. An obscure, non-fluctuating, slightly reddened swelling appeared over the third rib on the left side. Some months previously patient had complained of soreness in this situation, especially when the stethoscope was employed. A month after its first appearance the swelling became tender rather than painful, of a dusky red colour, and doubtful fluctua-

¹ Periostitis after typhoid fever, *British Med. Journal*, vol. i., 1885, p. 428.

tion existed. During the following week suppuration became evident; at the end of that time pus discharged; it continued for several weeks, and finally ceased without necrosis.

Etiology.—The causation of the disease is obscure. It appears to arise suddenly and apparently spontaneously, unless a slight injury in some part of the body determines where the periostitis will break out. Routier¹ contends that it is in every case the result of an injury. A blow or undue muscular contraction will suffice to produce the disease when the patient is enfeebled by an attack of typhoid fever. The possible septicæmic origin of the affection is suggested by Hayward,² who records an interesting example of the sequela in a patient sixteen years of age, and mentions several other cases that he had seen; in all the attack of typhoid was a severe one. In his patient the symptoms of periostitis on both tibiæ developed nearly seven weeks after the onset of the typhoid, and when the abdominal tenderness and diarrhœa had subsided. The disease was ushered in with severe fever, T. 104° (unusual), night sweats, anorexia, occasional shiverings, increased loss of flesh. Suppuration took place; discharge externally, no necrosis.

Keen³ offers an ingenious though unsatisfactory explanation of the cause of periostitis following typhoid. During convalescence from typhoid fever, and a little time after the complete cure, we find in the marrow of bone many mother cells containing blood corpuscles and large cells filled with pigment analogous to those which surround extravasated blood in the respiratory organs. These cells gathered together along the blood-vessels become stationary, owing to the slowness of the circulation, aided by an enfeebled heart. The circulation in the bone is seriously interfered with, and this may lead to gangrene of its tissue. This explanation presumes that central necrosis is the cause of the periosteal

¹ *Progrès Médical*, 1879.

² Periostitis following typhoid fever, *British Med. Journal*, vol. i., 1885, p. 16.

³ *Loc. cit.*

affection, a supposition which is negatived by clinical observations. Most surgeons will, I think, be inclined to believe that the specific fevers constitute a predisposition to a periostitis which may in some instances be induced by traumatism.

Symptoms are those of a subacute periostitis appearing during convalescence from an attack of typhoid. Persistent hyperpyrexia, when all the symptoms of typhoid have ceased, should place us on our guard, and will often enable us to discover disease of the periosteum.¹ Already a swelling exists, and the passage of the hand over the limb will reach a painful spot. From the fourth to the eighth day these symptoms become associated with sharp pains, skin remains normal, subcutaneous tissues become swollen, periosteum thickens, and is exceedingly tender to the gentlest touch, and beneath it pus may form. This is either absorbed or evacuated. Not unfrequently the periosteum may remain thick for some considerable time, and the periostoses which form constitute ineffaceable evidences of the disease. Mercier² has never known necrosis supervene, although patients have been followed for several months, some for a year and a half. Other observers, on the contrary (especially Keen), have observed the bone attacked with necrosis.

Treatment.—Mercier has found a blister applied to the swollen part from the very onset to be very useful. When suppuration takes place, the disease being chronic and circumscribed, it is better to allow the pus to be absorbed or to escape spontaneously. Internally tonics, such as cod liver oil. Counter irritants may be useful in removing any induration that remains.

OSTEITIS.

Osteitis or ostitis may mean inflammation of the entire bone, that is, involving all its constituent parts; or the term may be employed in a more restricted sense to signify inflammation of

¹ Mercier, *Revue Mensuelle*, iii., 1879, p. 21.

² *Loc. cit.*

PLATE.4 ✓



W. T. Sc.

the compact tissue only. As already intimated, French surgeons employ the word in its widest acceptation, while English writers adopt the narrower interpretation. In the following pages the term osteitis will be used to signify inflammation implicating the osseous tissue proper. Rarely occurring as a primary disease, it usually follows inflammation commencing either in the medullary tissue or in the periosteum. Placed as the compact tissue is between the cancellous interior on the one side and the periosteum on the other, it readily participates in a disorder originating in either of these structures.

Osteitis, as a primary affection, is rarely an acute disease. It generally assumes a chronic course (*fig. 4*, also *plate 4*), and among its causes are scrofula, syphilis, and rheumatism; it may also be induced by an injury, but in this case the osteitis is secondary to an inflammatory affection starting in the periosteum or the medulla, whence it spreads to the compact osseous tissue. The first change in the compact tissue, as the result of inflammation, is dilatation of the blood-vessels, with the accumulation of embryonic cells in the Haversian canals. These newly-formed cells are in every respect similar to those that fill the medullary spaces during the process of bone development, and are mostly produced from the constituent cells of the marrow; some are derived from another source, being leucocytes that have escaped from the blood-vessels. The effect of this new production of cells will be observed in an enlargement of the Haversian canals from absorption of their bony walls (medullization). The position of these enlarged Haversian canals

FIG. 4. ✓



FIG. 4. — Chronic osteitis and periostitis (*O. C. Museum*).

will be indicated when the periosteum is removed from the surface of the inflamed bone, by the presence of minute red drops in the openings of the canals. Microscopic examination of the bone will show that the osseous lamellæ are notched (Howship's lacunæ), the notches being filled with embryonic cells. As the process of absorption advances, the walls of adjoining canals melt away, and the large spaces thus formed are filled with newly-developed medulla. The cause of bone absorption is not as yet fully understood. Billroth¹ attributes it to the solvent action of lactic acid or acid phosphates which he discovered in the pus of chronic bone abscesses. It is known, however, that pus acts but feebly on bone sequestra, so that this theory cannot be considered satisfactory. Cornil and Ranvier² think that absorption of the osseous substance is analogous to the action of the vascular buds of the medulla, which act upon the osseous trabeculæ in the same way as medullary buds do in physiological ossification or as aneurism of the aorta on the vertebræ. In the character of the inflammatory process will be found the only reasonable explanation of the enlargement of the Haversian canals in osteitis.

The inflammatory products in osteitis may be absorbed or they may undergo various changes. Should the inflammation subside during the early stage, the embryonic cells disappear and the compact tissue will resume its normal appearance and structure. In other cases the inflammation proceeds to the formation of new osseous tissue in the previously enlarged Haversian canals. The osteitis is then productive and is characterised by the construction of a substance which is at first soft, then more or less hard, finally becoming osseous and blending with the original bone (sclerosis). The formation of new bone may go on simultaneously underneath the periosteum in the compact osseous tissue and in the medullary canal. In consequence of the deposit of new bone the compact

¹ *Surgical Pathology.*

² *Pathol. Histology*, English Trans., 1882.

tissue becomes thicker and heavier, while there is a decided diminution in the size or even obliteration of the Haversian canals. At more remote periods the increase in the size and weight of a bone becomes more evident ; it is then said to be condensed, hyperostosed, or sclerosed (*fig. 5*). Another termination of osteitis is in suppuration, which rarely occurs without being preceded by abnormal vascularity, plastic deposit, and increase in size from the formation of new bone. The latter

FIG. 5.

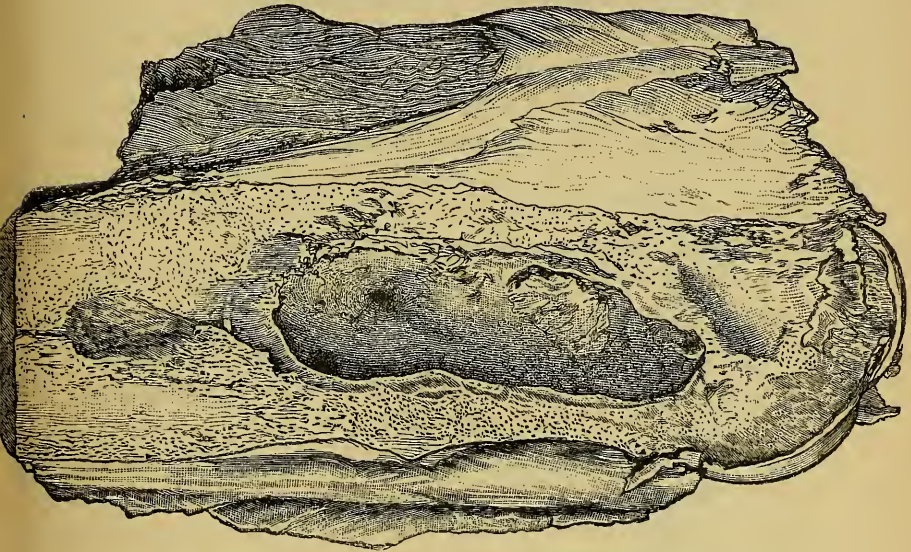


FIG. 5.—Suppurating cavity containing bone debris in lower end of femur. Complete obliteration of medullary canal, with great thickening and sclerosis of the bone above (*O. C. Museum*).

may be insignificant or non-existent when the inflammation pursues an acute course and quickly terminates in suppuration. Suppurative inflammation in the compact tissue of a long bone may or may not be associated with necrosis. When accompanied with necrosis, the death of the bone may be produced by the deposit of cells in the Haversian canals and their subsequent organisation exercising pressure on the nutrient vessels,

or the compression is occasioned by the pus. Necrosis once induced, the suppuration increases, the pus being produced in the Haversian canals also from a pyogenic membrane formed between the dead and living bone. In suppurative osteitis without necrosis the pus will be found on section of the bone in Haversian canals, which become dilated during the first stage of the inflammation. There will also be purulent centres occupying distinct spaces situated in the compact tissue which is frequently much sclerosed. It is interesting to observe the destiny of pus, hemmed in by thick condensed bone. It may entirely disappear by absorption, or the liquid portion may be absorbed, leaving caseous masses not unlike tubercles in appearance, but differing from them in that they do not undergo any subsequent changes. The presence of these caseous masses is a constant source of danger; at any time they may provoke an attack of acute inflammation, exposing the patient to great dangers, and frequently ending in the loss of a limb.

Symptoms.—Among the earliest is a dull aching pain located in the diseased bone. It is increased by handling the limb and by pressure, becomes more severe at nights, is influenced by the weather, being worse when it is damp and cold. The pain is soon followed by an œdematous swelling of the soft structures covering the inflamed bone, with scarcely if any change in the appearance of the skin. It is evident that often the symptoms of osteitis will be combined and mingled with those of periostitis and of osteomyelitis, diseases with which it is so frequently associated. The chief symptom showing implication of the compact tissue in the inflammatory change will be a deep-seated gnawing pain, with periods of improvement alternating with relapses.

Treatment should be constitutional and local. Among internal remedies iodide of potassium given in doses of from five to fifteen or twenty grains is still considered very effective. To alleviate the pain an opiate may be necessary. The local treatment will consist in the observance of rest, with the

application of warm fomentations or cold lotions, as the sensations of the patient indicate. The use of mercurial ointment locally may be of value. Should the symptoms point to the formation of pus within the compact tissue, the time will certainly have arrived for the employment of the trephine in the way mentioned in speaking of chronic abscess in bone. The trephine may moreover be usefully employed even in the absence of suppuration to lessen the tension and relieve the pain. (For tubercular and syphilitic osteitis, see tubercle and syphilis in bone.)

OSTEITIS DEFORMANS.

A special and exceptional variety of chronic osseous inflammation, first described by Sir J. Paget¹ (*fig. 6*). It usually commences about middle life or later, progresses very slowly, and may persist for a long period with no change in the general health and without any inconvenience except those inseparably connected with the changes induced in the diseased bones. The bones most frequently attacked are the long bones of the lower extremities and those of the skull, and, as a rule, the disease is symmetrical. Enlargement and softening, with alteration in shape, are the characteristic changes.

Symptoms.—Before any alteration in shape is observed in the bones the patient complains of obscure pains, usually regarded as rheumatic or neuralgic; and pains of a similar character also attend the progress of the disease. In an interesting case reported by Mr. Morris² the affection commenced at thirty, and when the patient

FIG. 6.

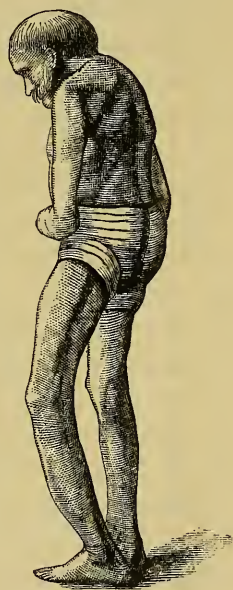


FIG. 6.—Osteitis deformans (*Sir James Paget's first case*).

¹ *Medico-Chirurgical Transactions*, London, vol. ix.

² *Trans. Pathol. Society*, vol. xxxiv., London, 1883.

came under observation at forty-two years of age the deformities, which are well depicted in a series of photographs accompanying the paper, were very characteristic and striking. Crampy sensations commenced in the right thigh, and were soon followed by alteration in the shape of the right femur and tibia, which were bent forwards and outwards. The right femur was first affected, then the tibia; as the bones began to bend they were observed to become nodular and enlarged in circumference. The left thigh bone and tibia then became diseased in a similar manner. For twelve months the patient had suffered much from pains in the back, which were influenced by the weather, being worse when damp. He had shortened five inches; natural height 5ft. 8in., now 5ft. 3in. No history of syphilis, scrofula, or cancer in the family. No alteration in the general health throughout.

The appearance presented by the patient on admission was peculiar and typical. Head bent forwards and downwards; legs and thighs bowed outwards, the deformity of the legs was almost symmetrical on the two sides. Tibiæ greatly thickened and uneven on their surfaces; the upper extremities are much enlarged, lower ends unaltered. Fibulæ appear normal. Femora thickened and much curved outwards and forwards. Iliac crests broader and rougher than normal. The spine, from junction of lower with middle portion of dorsal region, makes one long, continuous curve, with convexity backwards, up to third cervical vertebra. Ribs so nearly approximated that it is not possible to make out any appreciable intercostal spaces in lower half nor in posterior segment of chest; in front, spaces better marked. Clavicles much increased in size and in curvature, so that inner half projects forwards in one large, prominent curve. The head presents no marked abnormality, but the occipital and mastoid processes appear somewhat exaggerated, and patient says he requires a larger hat than he used to do. No change in the lower jaw. Upper extremities are not mentioned, so presumably there was no change. The urine was examined

carefully; the average daily quantity was 50 to 60 ounces; specific gravity, 1025-30; clear, amber colour, acid reaction; no albumen, sugar, or pus; phosphates and chlorides normal in amount. Quantity of urea passed frequently less than normal, 410 grains, instead of 500 grains, in twenty-four hours.

Butlin¹ discusses, in his report on Paget's case, the nature of the changes in this peculiar affection, and regards them as inflammatory. He observes that only three things could produce so great an increase in the size of a bone, namely, new growth, hypertrophy, or chronic inflammation. The first he sets on one side as being out of the question; nor is the second much more probable than the first, for the process is evidently no mere hypertrophy; so that of the three causes chronic inflammation alone remains. Microscopically, Butlin found the Haversian canals widened, with the walls, instead of being smooth, eaten out in a series of curves or concavities with the production of what are called Howship's lacunæ, so characteristic of bone inflammation. The tissue contained in the canals resembled that found in the spaces of inflamed bone, only differing from it in being generally more fibrillar and less rich in cells, the long duration of the disease and the tendency to organisation in the inflammatory products explaining the difference. The inflammatory character of the disease can, therefore, scarcely be doubted, and post mortem the bones exhibit the results of inflammation, involving chiefly the compact structure in the long bones, and frequently the whole thickness in the skull.

Symonds¹ case showed a striking deformity of one of the bones of the forearm, a drawing of which accompanies his paper. The patient, a woman sixty-nine years old, had been under observation for six years. Her father had suffered from rheumatic gout, yet he lived to the age of eighty; his hands were much deformed and he was lame. No history of tumour

¹ *Guy's Hospital Reports*, 3rd series, vol. xxv., p. 99.

or syphilis either in the patient or her family. It appears that the disease commenced when she was about forty-eight; the left shin began to curve forward; this took place without any antecedent pain and without apparent cause. Soon afterwards the right shin began to assume the same appearance. The deformity gradually increased, and remained the only symptom for about nine years, when she experienced aching pain in the right arm, chiefly from the elbow to the wrist. This was frequently so severe at night that rest was only obtained by hanging the arm over the edge of the bed. Very soon after this she noticed a deformity in the left forearm. The curvature of the radius had increased, and the bone had gradually assumed the position it at present occupies, without ever causing her more than an occasional ache. The right hip also became painful and prominent, and the lower two-thirds of the left femur were enlarged; all the while the general health seems to have been good. The deformity of the left radius was the most noticeable feature of this case. The bone was increased in size, and at the same time elongated, measuring $9\frac{7}{8}$ in. as compared with $9\frac{3}{8}$ in. the measurement of the left bone. Posteriorly it exhibited a marked curvature, which increased gradually in prominence to about the junction of the lower and middle thirds, where it terminated in a sharp ridge. The bone also curved forwards, bringing the hand into the prone position, and destroying the rotatory movements of the forearm.

Mr. Lunn¹ records a remarkably interesting and complete case of osteitis deformans in which the histological changes observed in the bones are described by Dr. Sharkey.

Treatment.—No treatment appears to have any effect on the progress of the disease. To prevent an increase in the deformity of the spine, and to assist the patient in maintaining the erect posture, Sayre's jacket or some spinal support might be applied. In Morris' case it relieved the pain in the back and legs.

¹ *St. Thomas' Hospital Reports*, vol. xiii., 1883, p. 43, with six plates.

The following papers and cases, in addition to those already mentioned, may be consulted with advantage :—Daly, Elongating hypertrophy of femur and tibia of opposite sides, *New York Med. Record*, vol. i., 1880, p. 225. Treves, F., Osteitis deformans, *Trans. Path. Soc.*, Lond., 1881, p. 167. Paget, J., Observations on Osteitis deformans, *Med. Chir. Trans.*, 1882, vol. lxx., p. 225. Pick, Osteitis deformans, *Lancet*, vol. ii., 1883, p. 1125. Silcock, A. Q., Specimens from a case of Osteitis deformans, *Lancet*, vol. i., 1885, p. 519. Paget, S., Bones from two cases of Osteitis deformans, *Trans. Path. Soc.*, Lond., 1885, p. 382. M'Phedrun, Osteitis deformans, *Med. News*, vol. i., 1885, p. 617.

CHAPTER IV.

OSTEOMYELITIS.

Syn. OSTEO-PERIOSTITIS, ENDOSTEITIS, PHLEGMONOUS PERIOSTITIS, MEDULLITIS, EPIPHYSARY OSTEITIS, TYPHUS OF THE LIMBS.

Inflammation attacking the medullary tissue occupying the central canal and the areolæ of the cancellous structure of bone, seen in its most typical form in the shafts of the long bones, especially the femur and tibia.

Historical.—Few diseases have received more names than osteomyelitis, about which during the last thirty years much has been written and many doubtful points cleared up. Authors have discussed its symptoms and morbid anatomy, and have defined it in accordance with their conception of the nature of the osseous tissue and the character and situation of the inflammation.

To Troja¹ must belong the credit of having first correctly appreciated the relation of the medulla to the bone. By destroying the marrow in the diaphysis of a long bone, he observed that the extent of the necrosis which followed corresponded to the amount of medulla destroyed, the periosteum also being detached to a corresponding extent. Cruveilhier,² repeating these experiments, destroyed the marrow through a perforation in the bone without previous amputation. In this way he was able to study the course of necrosis from the time a sequestrum is formed until it is eliminated through the cloacæ. He stated that he discovered pus in the medullary canal in patients who died from pyæmia after amputations, and

¹ *De Novorum Ossium Regeneratione Experimenta*, Paris, 1775.

² *Pathol. Anat.*, Paris, 1816.

inferred that the blood poisoning was induced by inflammation of the veins of the bone. These investigations were followed by those of Reynaud,¹ who wrote an interesting account of pyæmia following amputations and its relation to suppurative osteomyelitis; and by those of Porter,² Boyer,³ and Stanley.⁴ The last-named eminent authority described the disease at greater length than had been done by previous writers. Gerdy⁵ treated of the same subject under the name medullitis. He makes no reference to Stanley's work, so we may presume he was not acquainted with it. Although his account is in most respects accurate, he does not discriminate sufficiently between osteomyelitis and the other diseases of bone, and does not appear to have been acquainted with diffuse acute inflammation of bone arising independently of a direct lesion. Chassaignac,⁶ in 1853, gave the result of his experience, and wrote a classical description of the disease which he called "typhus extremitatum." Klose, of Breslau,⁷ having watched a number of cases of osteomyelitis, wrote in 1855 an exhaustive but one-sided account of the disease, which he designated "Separation of epiphyses a lesion of development" (*fig. 7*). Gosselin⁸ states "The disease originates in that part of the bone adjoining the cartilage, between the epiphysis and diaphysis;" hence the name which he proposes, "epiphysary osteitis." Frank,⁹ following Chassaignac very closely in his description, suggests the retention of the name separation of epiphyses, but with the prefix "inflammatory" attached. He observes that the

¹ *Archiv. Gén. de Méd.*, Paris, 1831, t. xxvi.

² *Pathol. conditions of Bone*, *Todd's Cyclopædia*, London, 1836.

³ *Traité des Maladies Chirurgicales*, Paris, 1845.

⁴ *Diseases of the Bones*, London, 1849, pp. 18 and 34.

⁵ *Archiv. Gén. de Méd.*, 1853.

⁶ *Memoire sur l'ostéomyélite*, read at the Academy of Science, Nov. 1853; *Gazette Médicale*, Aug., 1854, and following numbers.

⁷ *Vierteljahrschrift für die Praktische Heilkunde*, Jahrgang 15, Bd. i.

⁸ *Sur les Ostéites Epiphysaires des Adolescents*, *Archiv. Gén. de Méd.*, Nov., 1858, p. 513.

⁹ *Ueber Entzündliche Epiphysenlösung*. Inaug. Diss. Giessen, 1861.

number of bones attacked in some cases shows that constitutional causes, such as scrofula, constitute a predisposition to the disease, which may also arise from injuries, over-exertion, or exposure to cold, and occurs exclusively before the twenty-fifth year of life. Demme¹ writes on diffuse spontaneous osteo-

FIG. 7. ✓



FIG. 7.—Acute epiphyseal separation (osteomyelitis), following typhoid fever (*O. C. Museum*).

myelitis, and draws a distinction between the disease when accompanied or not by phlebitis, and considers the former by far the most destructive and malignant. It is unnecessary to do more than mention the works of Schutzensberger,² Louvet,³ and Culot.⁴ The work of Lannelongue⁵ has had a very

¹ *Archiv für Klinische Chirurgie*, 1862.

² *Gaz. Méd. de Strasbourg*, 1853.

³ *Thèse de Paris*, 1867.

⁴ *Thèse de Paris*, 1871.

⁵ *De l'Ostéomyélite aiguë pendant la croissance*, Paris, 1879.

important influence on the study of osteomyelitis, and has directed attention to the necessity for the adoption of early operative treatment. Reference will be made further on to the conclusions which he has adopted. Among English surgeons who have written on the acute diseases of bone Holmes' name stands out prominently. The work done during the American war deserves special recognition, and to Lidell's articles¹ I am indebted for much information and for many references to the work of other observers.

Osteomyelitis may be primary or secondary—primary when the inflammation commences in the medullary tissue, secondary when the disease is produced by propagation inwards from the periosteum. In young subjects, as already indicated, it is quite possible that an inflammation may be confined to the periosteum, involving perhaps the superficial layers of bone ; but the disease occurring in the medulla is almost invariably, if not always, accompanied by osteitis and periostitis. Osteomyelitis may appear spontaneously or be produced by injuries ; among its principal causes being contusions, concussions, and wounds of bone. It therefore constitutes a possible formidable complication of compound fractures and gunshot injuries. Many regard it as an infectious disease.²

The course of osteomyelitis varies much in intensity and duration. Occasionally the symptoms are exceedingly acute, and the disease ends fatally in a few days. At other times the symptoms are obscure, and the progress of the disease so slow that several weeks or months elapse before it reaches its full development. The affection may therefore pursue an acute, subacute, or a chronic course. It is, however, unnecessary and undesirable to institute separate varieties, the chronic form being in most instances merely the sequel of the acute.

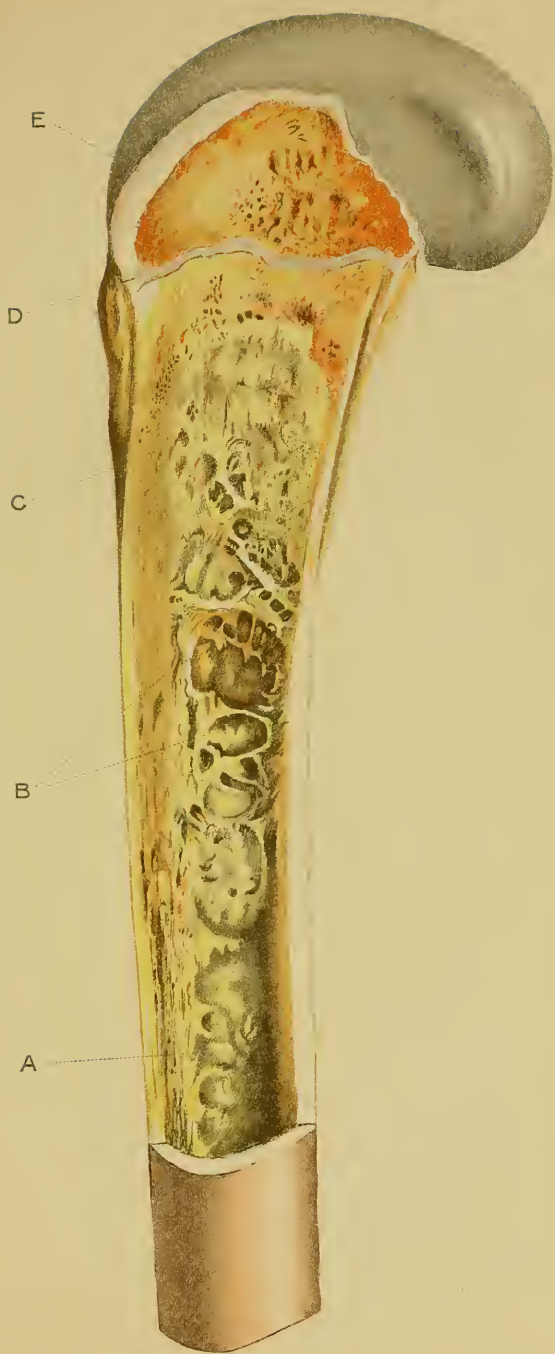
¹ *United States Sanitary Commission Memoirs, Surgical*, i., 1870.

² Bacterial origin of osteomyelitis is discussed in a separate chapter.

Acute osteomyelitis is a disease which occurs almost exclusively in children and young adults, at a time prior to the full growth of the bones, rarely seen after growth is complete. The physiological activity of the periosteum and medulla during the growing period constitutes an undoubted predisposition to acute inflammatory disorders in these structures. Males are very much more frequently attacked by osteomyelitis than females. Lannelongue¹ gives a table of one hundred cases, and the proportion of boys to girls is as seventy to twenty-eight; in the other two cases the sex was not mentioned. Another very instructive point brought out is the fact that the disease occurred between the ages of ten and twenty years in seventy-five per cent of the cases, the largest number being between ten and fifteen. One of the most prominent and undeniable features of the affection is the rapid formation of pus; this has led some pathologists² to regard the inflammation as essentially suppurative in character.

Predisposing Causes.—Age and sex constitute undoubted and important predisposing causes. The disease appears almost exclusively between four and twenty years of age, and most often between ten and eighteen. Occasionally it has been met with at twenty, twenty-five, and even thirty years of age, but these cases are rare. The disease may also attack very young children, well-marked examples of it having been seen at nine months and even at an earlier age. Lannelongue met with an example in an infant of five months. Mr. Irvin, of Lancaster, presented me with a femur removed from a child twelve months of age, who died with symptoms of acute traumatic fever. The bone, quite denuded of periosteum and dead, was surrounded by an enormous abscess, and during life the swelling was looked upon as a rapidly growing malignant tumour. Such cases are, however, exceptional, the general rule being that osteomyelitis attacks patients between eight and

¹ *Loc. cit.*² Cornil and Ranvier.





eighteen or twenty years of age. The peculiar tendency to the disease at this age is no doubt attributable to the activity of the circulation in the vicinity of the cartilages between the diaphyses and epiphyses during the period of growth; this supposition gains strength from the fact that the disease is peculiarly liable to attack those bones and to appear in the very situations where this physiological activity is most manifest—that is at the upper end of the tibial diaphysis, the lower end of the femoral diaphysis, and the upper extremity of the shaft of the humerus.

The fact that male children are more often attacked than female is probably owing to their being more exposed to injuries, one of the exciting causes of the disease.

Constitutional conditions have scarcely if any influence on the production of osteomyelitis. Scrofula has sometimes been stated to establish a predisposition to osteomyelitis, but there is not sufficient evidence to justify such a conclusion, the patients attacked bearing no marks of the affection. In the epiphyses, on the contrary, suppurative osteitis frequently occurs in those with a scrofulous history. Syphilis, as a rule, need not be entertained, as osteomyelitis is met with at that time of life when this disease is rarely seen, except as an hereditary affection. The influence of rheumatism has been urged by Chassaignac, Schutzemberger, Bœckel, and others; hence the name pseudo-rheumatism given to the disease. Giraldes also attached considerable importance to the rheumatic diathesis, especially in cases where the disease appears under the influence of cold and moisture. My experience, however, has taught me that neither the course of osteomyelitis nor its complications warrant us in admitting any connection between it and rheumatism. It is true that at the onset vague wandering pains in the limbs are present; this circumstance, no doubt, has led to the idea that rheumatism is in some way connected with osteomyelitis.

The season of the year appears to exercise some influence on the production of the disease, as in twenty-four cases the affection commenced between October and March inclusive, and in ten only between April and September; certain hygienic conditions, imperfect drainage, insufficient and bad food, may be regarded as producing a predisposition to the disease; in this manner possibly the greater frequency of the disease among the poor is to be explained.

Exciting Causes.—Injuries play an important part in the production of the disease. The following case may be regarded as a good example of osteomyelitis following a fall on the shoulder :—

ACUTE TRAUMATIC SUPPURATIVE OSTEOMYELITIS OF THE HUMERUS;
EARLY EMPLOYMENT OF THE TREPHINE; RECOVERY.¹

Case 2.—James C., aged eleven, half-timer in a foundry, was admitted into the Manchester Royal Infirmary on November 20th, 1886. Father dead; cause of death unknown. Mother, one sister, and two brothers living and healthy. The patient himself bears no indications of any hereditary disease. On November 11th he fell on his left shoulder. When he got up he was able to move his arm, and could put his hand on the top of his head. He had a good deal of pain at the time, and his arm has continued to pain him ever since. Next morning he went to his work, which consists in knocking off the rough pieces on iron castings with a hammer and chisel; and in the afternoon he went to school, but whilst there was sick, and had to go home. The pain was much worse that night, and three days later a medical man was called in, and on his advice a mustard plaster was applied to the shoulder, without any relief. The pain was of a shooting character, and began to increase in intensity about six p.m.

On admission the left shoulder was œdematous and hot to the touch; there was a very tender spot on the inner side about the coracoid process, and here fluctuation was very distinct. The whole arm was swollen, tender, and red, and the subclavicular fossa effaced. Urine: specific gravity 1020; alkaline; no albumen; no sugar; deposit of mucus.

On the 22nd the temperature of the right shoulder, taken by the surface thermometer, was 99°; of the left shoulder, 102°·2. The patient was put under chloroform, and an incision made on the front of the arm just below the junction of the upper epiphysis with the shaft. A considerable amount of pus was evacuated, and a piece of rough bone could be felt with the finger immediately to the outer side of the bicipital groove. A drainage-tube was inserted, and the wound dressed with iodoform and a wood-wool pad.

During the next three days the wound discharged very freely, but the tem-

¹ *Lancet*, 1887, vol. i., p. 824.

perature continued very irregular; on November 26th an exploration was conducted by Mr. Wright, who found the shaft of the humerus quite separated from its upper epiphysis. Some counter-openings were made, and the cavity syringed out with an antiseptic solution (sublimat 1 in 3000) and drained. There was no improvement either in the local or general condition, the evening temperature reaching 102°, and even higher. On the 30th he complained of a very tender spot on the outer aspect of the arm, an inch and a half above the external condyle. There was very little spontaneous pain in the limb, but when handled intense agony was experienced. The lad at this time presented a dusky appearance, and had a short distressing cough and a most rebellious diarrhœa. He was again anæsthetised, and a vertical incision an inch and a half long made over the tender spot; the incision was carried down to the bone through infiltrated and œdematous structures, and the periosteum found to be thickened and easily stripped off, but there was no pus beneath it. The bone was then trephined, and about a teaspoonful of pus escaped, the suppurating medulla being at the same time exposed. The upper incision previously made was now enlarged downwards; the periosteum here was found to be extensively separated from the bone, but there was no pus beneath it. The trephine was again employed, and the medullary canal laid open. While this was being done, some thick pus oozed up into the wound. The medullary tissue between the two trephine holes was then removed, the canal washed out with a perchloride solution (1 in 4000), and a drainage-tube passed through it, the ends projecting from the upper and lower wounds. The same night the boy complained of intense pain in his arm, which was being irrigated with a sublimate solution (1 in 5000), but after a subcutaneous injection of a quarter of a grain of morphia he passed a very fair night.

The next morning the patient was much better; his temperature had fallen to normal, and the limb, although still swollen and œdematous, was free from pain unless handled. The piece of bone from the lower trephine hole was eroded and eaten away on its inner surface until the part was translucent. The pus was evidently making its way out at this spot, which corresponded with an area of intense tenderness. During the days following the trepanation and clearing out of the medullary canal the temperature gradually fell, and kept down for about a week, except on December 3rd, when there was a slight rise owing to a block in the drainage-tube. On December 8th the temperature again began to rise, and the next day the patient was placed under the influence of chloroform, the drainage-tube removed, the medullary cavity syringed out, and a piece of rubber catheter placed in the lower sinus. The temperature continuing to rise, on the 11th the patient was again put under chloroform, and the upper end of the diaphysis was discovered to be quite loose, soft, inflamed, and infiltrated with pus. The epiphysis moved smoothly in the glenoid cavity, and the joint was apparently quite unaffected. The upper extremity of the diaphysis had been causing much annoyance and pain, so about an inch of it was removed. The wounds were dusted over with iodoform, and the sublimate irrigation continued. After this operation the temperature began to fall, and came down nearly to normal. The medullary canal was syringed out daily, and on the 21st the irrigation was discontinued, the wound being dusted over with iodoform and covered with a wood-wool pad. The medullary canal soon began to fill up with granulations, and by January 15th, 1887, it became impossible to force any

fluid through it. The temperature about this time on more than one occasion rose to 102°. There was nothing local to account for it, nor did the lad's general condition indicate anything going wrong; it had been steadily improving for at least ten days. His appetite was remarkably good, and except when the arm was moved, he complained of no pain whatever. The piece of catheter in the lower opening was removed on February 1st, and its removal did not occasion any rise of temperature. The discharge from this sinus steadily decreased. The granulations in the upper openings were exuberant, and painful when the dressings were renewed. In the centre of the original opening there remained a distinct sinus, which led down to some dead bone. On February 12th he was again anæsthetised, the sinus was enlarged, and a small sequestrum removed from the upper end of the diaphysis. The prominent painful granulations were scraped away at the same time, and the several surfaces dressed as before. After this, the patient's temperature remained normal, the arm was dressed every other day, the discharge visibly diminishing.

The patient left the Infirmary on February 26th, with two sinuses, the original opening and the trephine-hole, still discharging a little. His condition at the present time (April, 1887) is much the same, a small amount of pus escaping from the two sinuses. The arm is thicker than its fellow, from the large amount of new bone which has been formed by the periosteum; the shoulder and elbow joints are quite movable, and the boy has more than regained his original state of health.

In many cases, however, no such history can be elicited; in these not unfrequently it will be found that cold and exposure combined, perhaps with fatigue,¹ are the directly exciting causes.

ACUTE IDIOPATHIC SUPPURATIVE OSTEOMYELITIS OF THE FEMUR; PYÆMIA;
AMPUTATION AT THE HIP JOINT; DEATH ON THE TWELFTH DAY.

Case 3.—John H., age fourteen, collier, admitted August, 1883. Has always enjoyed good health, and always had good food and plenty of fresh air. No scrofulous antecedents. Fifteen days before was sitting about half an hour on some cold flags, and on getting up felt pain for the first time in his right thigh. It was soon followed by a swelling, which by the next morning had increased very much, the patient at the same time complained of headache and dizziness. The pain in the thigh he describes as deep seated and throbbing in character. The swelling continued to enlarge for three days, and then stopped. Poultices were applied to thigh. At the end of a week a swelling appeared in the front of the chest, a little to the right of the sternum. On admission patient was very much emaciated, with a hectic flush, and had an enormous swelling on the right thigh. The limb was hot and very tender; fluctuation could be detected in several situa-

¹ In a communication (Intern. Med. Congress, 1884) "On periostitis caused by over fatigue in soldiers," Dr. Laub (Copenhagen) said that the disease occurred almost exclusively in the tibia, and had a preference for young soldiers. Course of disease subacute, never suppurating, often ended by formation of hyperosteal plates of new bone.

tions, but especially just above the knee on the inside of the limb. The pain was very severe and of a jumping character. Knee and hip joints unaffected. There was a circumscribed and fluctuating swelling over the chest, evidently a collection of matter. An incision made into the thigh swelling evacuated about a pint of foetid pus, and on passing the finger into the wound the femur was found extensively denuded. The cavity was washed out with carbolic solution (1 in 30) and drained. The temperature continued high, 101° to 103° , and no improvement took place in the general condition. The knee joint became affected and suppurated. This materially increased the general distress and suffering. The case appeared hopeless, for the system seemed to be seriously compromised. Amputation was decided upon, although the chances of success attending it were exceedingly small. The flap operation was performed, and as we were clearing the femur in its upper third for the application of the saw, slight traction severed the bone and enabled us to remove the limb. The suppurative inflammation had completely destroyed the bone at this part. As the mischief involved the portion of femur that was left, exarticulation of the hip was deemed necessary. The acetabulum and head of femur were healthy. During the operation the patient became very collapsed, which necessitated the application of hot sponges to the cardiac region, and the subcutaneous injection of ether. He rallied and at first there was some improvement in his general condition. An uncontrollable diarrhoea set in on the sixth day and continued despite all remedies, death taking place twelve days after operation. Post mortem examination showed pyæmic abscesses in the lungs and kidneys. Systemic infection took place early, the abscess on the chest which appeared on the seventh day of the illness being no doubt of pyæmic origin.

Tired children, says Gosselin, are very liable to osteomyelitis. Lannelongue¹ gives a remarkable instance of acute osteomyelitis in a girl thirteen and a half years of age, who, after a fall, injuring the forearm, placed the limb in cold water for some hours. Alarming symptoms of osteomyelitis set in, and in three days she died from acute pyæmia. Post mortem: The radius was found infiltrated with pus, with hæmorrhagic softening of the marrow, pus in the medullary canal, and subperiosteal abscess around the bone; phlebitis of veins of forearm; metastatic abscesses in the lungs, also in the walls of the heart. It is possible that cold acts by slowing the circulation, which leads to arrest of the blood cells, and possibly of the bacteria, circumstances favourable to the development of these parasites.² Again, debility from overwork induces a

¹ *Loc. cit.*

² Thellier, De l'ostéomyélite spontanée dans son étiologie et sa pathogénie, Thèse, Paris, 1883.

condition of the system in which the causes already mentioned readily produce acute osteomyelitis.

Seat of Disease.—The whole skeleton is liable, but the long bones are those usually affected; the short and flat bones are, however, not exempt. Among the cylindrical bones, those of the lower limbs suffer most, especially their diaphysial extremities, the disease showing itself very frequently near the lower end of the femur and the upper end of the tibia (*fig. 8*).

FIG. 8. ✓

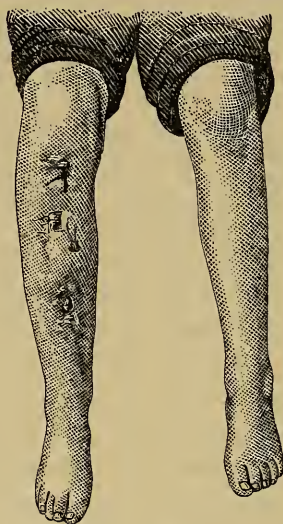


FIG. 8.—Acute osteomyelitis of the tibia; cicatrices showing common position of sinuses.

It has also been seen in its acute form in the humerus and clavicle. Several bones may be attacked simultaneously, the disease then apparently arising from some general blood infection.

*Symptoms.*¹—The first symptom is a severe local pain,²

¹ In the traumatic osteomyelitis occurring after amputations and compound fractures, the symptoms are closely allied to those of the disease encountered during the growing period.

² The character and intensity of the pain will vary with the condition of the bone; it is most marked in those cases where it is entire.

sometimes preceded by obscure, erratic pains situated in the limbs at the level of the articulations (Giraldes). The pain is located in the part where the morbid lesion first appears, and there, on subsequent examination, the gravest changes are discovered. It increases in severity as the disease becomes more pronounced. It is deep seated, excruciating, and aggravated by the least pressure or the slightest movement of the limb; it also increases towards evening and at night, the nocturnal exacerbations reaching their maximum after some hours of distress, when they gradually abate or subside, to be renewed again the following night. Patients often labour under the impression that the limb is broken, the sensation they experience being compared to that attending fracture of a bone.

Very soon after the onset of the pain an indurated swelling, intimately attached to the bone, of which it seems to form an integral part, appears. This swelling possesses several peculiarities which must be dwelt upon, as they contribute very materially to the diagnosis of the disease. The limit of the painful induration has a hard, resisting border, which in most cases gradually extends in an upward direction, and this margin coincides very nearly with the extent of the disease in the interior of the medullary canal. This mode of extension was very well marked in a case of acute spontaneous osteomyelitis, which is reported in the *Medical Chronicle* for November, 1884.

As already mentioned, the inflammation speedily terminates in suppuration, which rapidly and uniformly involves the periosteum and the parts surrounding the bone, acute periosteal abscess and diffuse cellulitis almost always coexisting with acute osteomyelitis; so that, although suppurative periostitis may and does exist without suppuration within the medullary canal the converse is seldom true. After a few days, fluctuation becomes evident in the hard swelling, and if the periosteum is destroyed and the pus is permitted to break through it and spread among the muscles, its presence can no longer be a matter of doubt. Wherever osteo-periostitis exists in a bone

thinly covered, *e.g.* the tibia, the swelling appears very quickly, and the difficulty attending the diagnosis of suppuration is rarely encountered.

The quality of the pus varies much; sometimes it is thick and creamy, sometimes sanious and fœtid, and frequently on the surface oily drops will be found, which, according to Chassaignac, is indicative of denudation of bone. It is certain that this peculiarity also exists in acute periosteal abscess, but not in phlegmon, a point of some importance in forming a diagnosis. When the pus is abundant, thin, and of a reddish colour, it often indicates the peculiar severity of the disease; in such cases typhoid symptoms are often predominant.

The appearance of the skin over the swelling will also vary; when the bone attacked with inflammation is not far from the surface, the skin presents, after a short interval, a reddish hue, and it soon becomes phlegmonous. When, on the other hand, the bone is well covered, the skin will after a few days exhibit a pale appearance, succeeded by evidences of congestion, associated with disseminated erythematous patches, which fade under pressure of the finger. The temperature of the part is increased, as can be readily detected by the application of the hand, or by the surface thermometer.

So far, the local appearances have alone been considered. The general symptoms resemble in many respects those which precede and accompany the continued fevers, more especially typhoid, with which osteomyelitis is often confounded. In the very acute cases a rigor generally indicates the commencement of the disease; this is soon followed by a fever which is very severe and has no remissions for a week or ten days, when it often diminishes. Rigors may also occur at a later period, when they indicate implication of a joint in the suppurative inflammation or point to purulent infection of the system.

The skin is hot and dry, pulse quick, at first full and bounding, as in other acute inflammations, becoming small

and compressible as the disease advances. Soon the patient's strength begins to decrease, his face indicates exhaustion, the tongue, at first furred, dries and becomes red at the tip and margins, the lips and teeth are covered with sordes; there is excessive thirst, bilious vomiting, with abdominal pains and distension, and at an advanced stage of the disease there may appear a troublesome and exhausting diarrhœa, which resists the remedies ordinarily employed. There is usually delirium with the fever, at first during the nights only, afterwards it may become constant. The fever generally reaches its height while the pus is forming, and partly subsides as soon as the purulent collection is evacuated. It does not, however, completely disappear at this stage, wherein it differs from the fever accompanying acute periosteal abscess, which quickly passes away when an evacuative incision is made.

Diagnosis.—This is often very difficult; at times the most experienced practitioner will have great difficulty in expressing a definite opinion with regard to the nature of an acute bone affection, and in saying whether the disease is simply periosteal or whether the interior of the bone is affected at the same time. The subsequent course of the disease will give valuable information on this point.

If the acute symptoms subside after the pus has been evacuated, and the patient begins to improve, the chances are greatly in favour of a primary periosteal disease, with or without superficial necrosis. If, on the contrary, the improvement is only very temporary, the fever and the other symptoms again appearing, we are in the presence of a much more formidable affection.

At the onset the constitutional disturbance attending acute osteomyelitis is not unfrequently confounded with the premonitory symptoms of the eruptive fevers, more especially typhoid; the extreme painfulness of the affected limb and its tenderness on pressure should usually prevent this mistake being made. Rheumatism presents some points of resemblance to osteo-

myelitis, particularly at the onset of the latter disease, when erratic pains are frequently met with. Fixation of the pain in one limb, which is exquisitely sensitive to pressure, and the discovery of a deep-seated swelling in intimate connection with the diaphysial extremity of a bone, assist us here in coming to a definite diagnosis. When suppuration is once established, osteomyelitis may be taken for diffuse phlegmon. Fortunately the treatment is identical in both affections. An incision to evacuate the pus is absolutely essential in both instances; and we then determine the presence or absence of bare bone, and make a diagnosis accordingly.

Results.—The disease often ends fatally, death taking place in some very acute cases during the first week, from the intensity of the febrile disturbance; usually however, in fatal cases, death does not occur until a much longer period has elapsed. In that case bedsores are very often produced, the mucous membrane of the mouth becomes covered with aphthous deposits, and symptoms of pyæmia not unfrequently develop. Should the patient's strength be equal to the demands made upon it during the acute stage, the disease may terminate in recovery. This can only ensue after a tedious process of separation of necrosed bone, or after amputation, the indications for which often arise during the first month. In some very rare instances the inflammation subsides before arriving at the suppurative stage, the disease ending in resolution.

The mode in which the disease advances in osteomyelitis is, as a general rule, in an upward direction; in many cases the cartilage between the diaphysis and epiphysis prevents the inflammation spreading to the latter. Sometimes, however, the cartilage is slowly destroyed; the inflammatory process then reaches the spongy structure of the epiphysis, through which it extends, perforates its thin, compact layer, and arrives at the joint through rounded erosions of the articular cartilage (*fig. 9*). Joints may also be invaded in other ways.

the inflammatory process extending along the fibro-synovial structures, or possibly along the lymph vessels. The articulation once reached, the inflammation may extend to a higher point by rupture of the synovial pouch; this allows the contents to spread among the muscles in the contiguous part of

FIG. 9. ✓

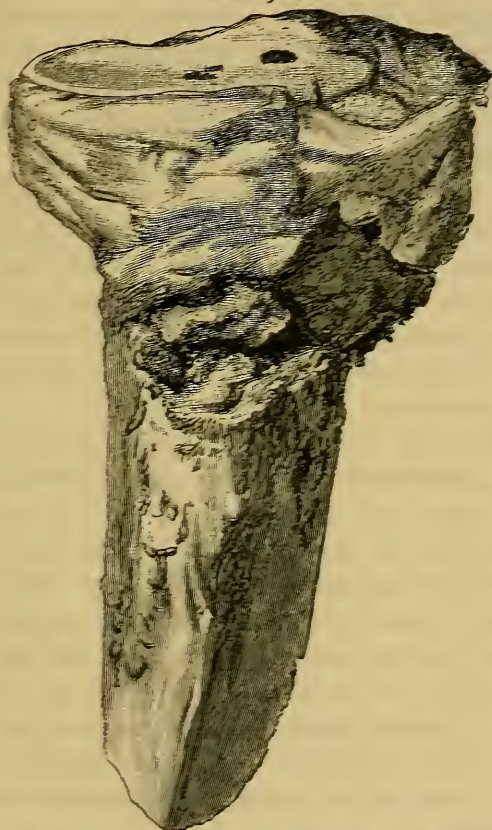


FIG. 9.—Osteomyelitis of the tibia, showing extension through upper epiphysis into the knee joint by round perforations of the encrusting cartilage (*O. C. Mussetum*).

the limb, and disease of the subjacent bone may be induced. The extension may also proceed directly from the synovial membrane to the periosteum.

Exception to the rule of upward extension and implication of the articulation above the diseased bone is often seen in disease of the lower end of the femoral diaphysis. In such cases I have witnessed the knee joint involved in a suppurative inflammation which has reached the articulation not by direct extension through the separating cartilage, but by spreading along the fibrous structures. In the same manner I have seen the ankle joint attacked in disease of the inferior third of the tibia, and where the affection commences in the upper ends of the shafts of the tibia or humerus, the inflammation often extends downwards a considerable distance.

Another, but more rare consequence of osteomyelitis is, the separation of the diaphysis from the epiphysis owing to the gradual solution of the cartilage of conjunction; the separated extremity of the diaphysis may finally perforate the skin and be extruded or removed. The separation usually takes place at one end of the diaphysis only, but sometimes the process may go on at both its extremities.

Coincident with its upward extension in the medullary canal, the inflammation spreads in a transverse direction; secondary osteitis and periostitis being set up, and perforation of the bone or a solution in its continuity resulting. The products of the inflammation quickly suppurate, pus being found in the Haversian canals and under the periosteum, stripping the latter from the bone and thus assisting in the production of necrosis. In time a sequestrum (*fig. 10* and *plate 5*) is formed, which nature in the usual way attempts to replace and to remove. Spontaneous fracture may also occur as the result of the rarefactive and suppurative osteitis which is set up.

Prognosis.—This will depend upon the general symptoms; if these are merely inflammatory, the patient's chances are of course much better than when typhoid symptoms set in early, and become quickly established. The prognosis may materially alter during the course of the affection, the graver symptoms,

in some cases, disappearing as soon as the incisions are made. Should the improvement continue and the remission be maintained for some days, the prognosis will be favourable as regards the immediate future. But the patient will have to pass through a tedious time of bone separation before the cure is in any way complete. The worst cases are those in which the symptoms throughout have been of an adynamic character. It is most difficult to predict the duration of the disease, which varies from a few days to several months. In the graver forms a fatal issue may attend the severe constitutional symptoms within a short time of the onset of the affection, or the acute process may subside after a few days, to be followed by a subacute course with possibly recrudescence of the disease from slight causes.

Morbid Appearances.—Taking into consideration the morbid lesions encountered, osteomyelitis may be regarded as either a simple, suppurative, or in rare cases gangrenous inflammation. The simple¹ variety is found in conjunction with osteitis and periostitis. It exists to a limited extent in most cases of simple fracture, and is not characterised by any special clinical phenomenon.

The histological changes indicative of simple osteomyelitis (so called carnification or hepatization of the marrow) are hyperæmia, with cell multiplication affecting the corpuscular elements of the marrow and the connective tissue of the Haversian systems. Carnified marrow, a good

FIG. 10. ✓



FIG. 10.—Acute osteomyelitis of tibia, implication of knee joint, sequestrum invaginated (*O. C. Museum*).

¹ To this form the term chronic osteomyelitis is applied by some writers.

example of which is to be seen in the mass of granulations projecting from the sawn end of a bone a few days after an amputation, is of a firm, almost fibrous consistence, generally of a red colour, sometimes, however, it is very dark, or even black, from extravasation of blood. From this condition the marrow may return to its normal state, or the carnification may be the stage prior to and immediately preceding suppuration. A third termination is ossification, the new bone often leading to serious encroachment upon or even obliteration of the medullary cavity (ossifying osteomyelitis).

Suppurative osteomyelitis, the disease which has been described in the foregoing pages, and in which pus appears to be the principal product of the inflammation, is in the majority of cases preceded by carnification of the marrow or simple osteomyelitis. This can be observed in cases where the disease travels slowly upwards within a cylindrical bone; the lower portion of the marrow will be suppurating, while at a higher point the medullary tissue is hepatised only. The cell elements of the granulation tissue are transformed into pus corpuscles, the change beginning in several separate centres which afterwards unite, so that at first numerous punctiform abscesses are found disseminated through the congested marrow. The growth and coalescence of these inflammatory foci is in some cases, where the inflammatory process is very intense, so rapid that the suppurative variety of the disease may be almost regarded as the primary affection. When the suppuration within the medullary canal is widespread, the disease must be regarded as among the gravest we have to deal with; troublesome necrosis with its attendant evils being the inevitable consequence, and very often the advent of general blood infection leads to a fatal result.

The gangrenous form of osteomyelitis indicates a more intense degree of irritation than that which determines the other varieties of the disease. The medullary tissue presents a dark appearance, its structure being completely destroyed;

PLATE. 5. ✓



W. T. Sc.

the resulting products decompose, and exhale an exceedingly offensive putrid smell. The decomposing mass is principally made up of granular debris derived from pre-existing corpuscles, together with shreds of connective tissue, the whole being of a dark colour, from admixture with decomposing blood constituents.

Treatment may be considered under the two heads, local and general.

Local.—Whenever the symptoms point to commencing osteomyelitis we must insist on absolute rest, as the timely adoption of such means may possibly check a threatened attack. Care must be taken not to regard too lightly persistent so-called growing pains; these are not unfrequently the precursors of an acute inflammation, which rapidly ends in suppuration. When the disease has fairly commenced the need for repose is imperative. Fortunately the pain experienced on the least movement causes the patient instinctively to seek rest. We must refrain from adopting any mode of treatment likely to debilitate the patient; the application of leeches is of doubtful service; and cold must be avoided, as it may intensify the disease. When the pain is severe and no swelling can be discovered opium may be prescribed; and at this stage the administration of quinine and salicylate of sodium may be attended with benefit.

As soon as the swelling appears an incision through the periosteum should be made; it will relieve the tension, and, according to Verneuil, it is the best substitute for a leech. It is certainly not necessary to wait until we are sure of the presence of pus before the incision is made. A tenotomy knife is very useful for diagnostic purposes when the bone is well covered. The incision should be free and so placed that the pus can flow freely, otherwise the wound assumes an unhealthy appearance, and the matter will burrow in all directions. Relief is in some cases obtained by early incision; the disease, however, rarely subsides entirely at this stage.

After a few days of temporary improvement the symptoms return with renewed severity. It then becomes a question of resorting to some means of opening the medullary canal. Under such circumstances the indications for trephining are to my mind unquestionable. We have ample proof that the trephine was adopted in such cases by the older surgeons. Hunter,¹ in treating of suppuration in medullary parts of bone, says: "The treatment of such cases is various, and the cure is generally very difficult. They are seldom understood; at first they may appear as a common abscess, and are often opened and dressed as such, which proving generally ineffectual, leads the surgeon to a more particular examination, and he easily discovers a diseased bone if the opening has been free. As the bone cannot be dilated by a cutting instrument, it must be killed either by the potential or actual cautery, or sometimes *the trepan* will be useful."

The trephine was also employed in America as far back as 1798 by Dr. N. Smith, and with the best possible results. It is difficult to understand why the operation has been almost entirely relinquished when we know the beneficial results obtained by its adoption in acute bone diseases. Incisions of great value from a diagnostic point of view, and in the treatment of two very constant and almost inevitable complications of osteomyelitis—subperiosteal abscess and diffuse phlegmon—have very little influence on the progress of the inflammation in the interior of the bone. The only plan likely to be of any service is the making of an opening in the bone itself through which the pus can escape and the suppurating marrow may be removed.

In adopting this mode of dealing with an intraosseous suppurative inflammation, we copy the method by which nature endeavours to find an exit for the exuded fluids—

¹ Hunter's Works, Palmer's edition, vol. i., p. 515-516, London, 1837.

that is perforation of the bone by a process of ulceration, the natural procedure, however, must be slow and often imperfect, and while it is being executed the risks of septic and other complications are imminent. If then, notwithstanding early and free incisions through the soft parts, including the periosteum, the symptoms of osteomyelitis continue, it becomes the surgeon's imperative and urgent duty to tunnel the bone, and for this purpose the trephine is the most suitable instrument. It is quite possible the hesitation to trephine may arise from the difficulties naturally surrounding the diagnosis, or the fear that harm will result from interference in cases where no pus is discovered. With the observance of antiseptic precautions the latter objection is groundless; the operation being, in my experience, perfectly harmless.

From what has been said about the symptoms of osteomyelitis, it will be gathered that the situation where the disease commences and where it is found in its severest forms is at the ends of the diaphyses, more especially the lower end of the femoral and the upper end of the tibial diaphyses. These will constitute the seats of election where the trephine openings are to be made.

In young subjects it is necessary to remember that the medullary canal does not extend quite as far as the epiphyses, so that a second opening may be requisite. A single incision will be all that is required, the second trephine hole being made about an inch distant from the first. In case the suppuration has existed for some time and is consequently very extensive, the periosteal separation will generally indicate the position where another opening into the medullary canal may be made with advantage; the suppurating medulla between the various holes must be scooped out, the canal thoroughly cleansed with a disinfectant and some iodoform introduced into the cavity. Lannelongue¹

¹ *Loc. cit.*

is of opinion that the formation of a subperiosteal abscess is not necessary before the trephine is applied, and that the more promptly trephination is resorted to the more efficacious it will prove to be; when we are in the presence of local and general symptoms pointing to osteomyelitis, and we discover a zone of excessive pain near the diaphysial extremity of a bone, it is advisable to incise the soft parts which cover it and trephine the bone at this level without delay.

I wish cordially to support this dictum, and feel persuaded that if it were more universally adopted, the disastrous results of osteomyelitis which we so constantly witness would become infinitely less common. Unfortunately the cases brought into hospital have generally passed the acute stage, and merely seek admission for the purpose of getting rid of the consequences of the inflammation; often simply to have a sequestrum removed.

The opinion of some other authorities in favour of early trephining may be quoted with advantage. Ollier¹ says "the inflammations of bone are to be treated like those of soft parts; if pus exists we must evacuate it. In the presence of acute osteitis, which has not been arrested by ordinary antiphlogistics, the primary surgical indication is, to divide the periosteum freely, and if the symptoms are very severe, especially if the disease is of the infectious variety, we must resort to early trepanation, which acts as a medullary drain. Trepanations made antiseptically do not produce necrosis; they constitute, on the contrary, the best means of preventing it." Bryant² is of opinion "that a free incision down to the bone in periostitis as well as in endostitis does nothing but good, and drilling or trephining inflamed bone, even when it fails to cure, tends to check the progress of the disease and relieves pain."

Although this treatment is urgently called for in osteomye-

¹ *Traité des resections et des opérations*, Paris, 1886.

² *Guy's Hospital Reports*, 1879, 3rd series, vol. xxiv.

litis occurring in bones having a considerable thickness, such as the femur, tibia, and humerus, in those of smaller calibre, as the radius or fibula, the compact tissue is destroyed more quickly, and this, allowing the pus to escape more easily, explains the frequently less urgent character of the symptoms in osteomyelitis of these bones and the increased chances of a cure being effected; this is shown in the following case:—

ACUTE SUPPURATIVE OSTEOMYELITIS OF THE CLAVICLE; NECROSIS;
SEQUESTROTOMY; RECOVERY.

Case 4.—J. L., aged thirteen. In February, 1885, went to one of the public baths, and, as he would not get out when requested, the bath attendant applied the hose, which apparently injured the right shoulder. The following day he felt chilly, and kept as near the fire as possible; however, he was sufficiently well in the morning to attend school. The next day, feeling ill, he went to bed as soon as he came home and remained there two days, when he became feverish and delirious. A medical man was now called in, who pronounced the illness to be a feverish cold. Three or four days later a severe pain commenced in the right clavicle, and in order to relieve it hot bran bags were applied. Soon afterwards a swelling appeared, which, after the lapse of a month, was lanced and pus evacuated. The discharge continued, and about twelve months later, when I saw him, extensive necrosis existed. Several sequestra were removed and a large cavity in the bone exposed. The boy made a good recovery, and now enjoys robust health.

Each cylindrical bone presents at its extremities a region where it is easily accessible; the upper end of the femur can be readily reached on the outer side below the great trochanter, while its lower end is within easy reach on the outer side of the thigh, in front of the biceps tendon. The anterior surface of the tibia, being subcutaneous in its entire length, is very well situated for incisions or trephining.

An exceedingly grave complication of osteomyelitis is implication of a neighbouring joint. In these cases amputation has been the general plan of treatment. In young subjects, before resorting to this extreme measure, an attempt must be made to save the limb. Trephining the bone will have to be combined with free incisions into the joint. These latter should be made in the positions most favourable for drainage, and the articulation must be frequently cleansed with disinfectants. In a case of osteomyelitis of the lower end of the tibia

with arthritis of the ankle, Ollier resected the lower end of the diseased bone, and the patient recovered, with a moderate amount of reproduction of bone. Chassaignac¹ regarded amputation as the only efficacious treatment in suppurative osteomyelitis, and recommended that the operation should be performed as soon as the diagnosis was certain, the point of election being the first healthy joint above the diseased bone. This rule is far too absolute, for we know that recovery has taken place when the disease has been treated in less severe ways. The operation may, however, be rendered necessary when conservative treatment, particularly the use of the trephine, has been unsuccessful.

It is doubtful whether amputation in the continuity of a bone attacked by osteomyelitis should not be rejected, as the disease is very likely to reappear in the portion of bone that is left; for this reason disarticulation or amputation in the continuity of the bone placed immediately above is strongly recommended as the most successful operation. For example, disarticulation at the knee or amputation through the thigh in case of disease of the bones of the leg, and removal of the limb at the hip joint when the femur is attacked by the disease. The operation is contra-indicated when several bones are simultaneously diseased, also when typhoid symptoms are present in a severe degree, the appearance of pyæmic symptoms will also, as a general rule, render amputation inadmissible. There are cases, however, where the operation has been successfully practised, even under these circumstances. Fayrer² records a case of amputation at the hip joint for osteomyelitis of the femur, after removal of the thigh in the lower third. The operation was successful, although at the time of the second amputation the patient was very low and suffering from indications of blood contamination. König³

¹ *Loc. cit.*

² *Clinical Surgery in India*, London, 1866, p. 607; see also *Clinical and Pathol. Observations in India*, London, 1873, Cases of Osteomyelitis and Pyæmia.

³ *Centralblatt für Chirurgie*, 1880, No. 14.

records a case of amputation through the thigh where on division of the femur the saw passed across a large collection of putrid pus within the medullary canal. He hesitated to amputate at the hip joint, owing to the condition of the patient. The putrid and degenerated marrow was removed from the medullary cavity, and plugs impregnated with zinc chloride were employed to cleanse the canal. This case, which recovered, shows the possibility of successfully dealing with acute suppurative and putrid osteomyelitis by removal of the marrow.¹

It often happens that when we amputate for suppurative osteomyelitis we discover the state of the bone to be such as to necessitate removal of the limb at a higher point. Flap amputation has this obvious advantage over the circular method, that it lends itself very readily to amputation at a higher spot than had been previously arranged. Again, not unfrequently we discover purulent infiltration extending upwards a considerable distance among the muscles which have been preserved; with the flap operation it is an easy matter to find out and to deal with this awkward complication, which in neglected cases occasions trouble. The parts should be freely spooned, thoroughly cleansed with a strong bichloride solution, and carefully drained.

Subperiosteal Resection.—Early removal of a part or of the entire diaphysis, before the formation of any new bone, has been practised with success. This method of treatment, first suggested by Mr. Holmes, possesses altogether special indications, so that it is not comparable with any of the modes hitherto mentioned. It is not proposed that the operation should be performed before the subperiosteal abscess is evident. It then offers itself as an expedient which removes a source whence the system is easily contaminated, besides

¹ A case very similar to this occurred at the Children's Hospital, Pendlebury, in September, 1886, and is published in the *Medical Chronicle*, December, 1886, p. 200.

limiting what would otherwise be a prolonged suppuration. Another consideration which weighed with Mr. Holmes¹ was that by subperiosteal resection the tedious convalescence which accompanies the invagination of the sequestrum is obviated, and the difficult and embarrassing operations by which such a sequestrum has to be removed are rendered unnecessary.

Resection then is indicated, when the osteomyelitis is limited, and the discharge likely to drain the patient's strength; but it is more than probable that the manipulations necessary to effect an early resection, may subject the bone to such an amount of violence as will tend very materially to aggravate the disease. The results, however, which have already been obtained, appear to indicate that in resection we may have an additional resource, which can be practised in diaphysary osteomyelitis when the state of the patient indicates a tendency to rapid exhaustion from excessive suppuration.

One of the most successful examples of subperiosteal resection for acute periosteal abscess published is that reported by Mr. Holmes.² The patient, a lad aged ten, was admitted into the Hospital for Sick Children, April 5th, 1865, on account of subperiosteal abscess of tibia dating from March 15th, commencing without known cause with pain in the ankle followed by swelling of the leg. The abscess had been opened on March 20th by a small puncture, but the disease continued to extend. The incision was enlarged, the bone found to be extensively denuded, and there was fluid in both the knee and ankle joints. Examination under chloroform showed the bone to be denuded as far as Mr. Holmes could reach with the finger. Notwithstanding the extent of the mischief, it was determined not to amputate, as the boy's condition was evidently im-

¹ *Surgical Treatment of Children's Diseases*, London, 1868, p. 387.

² *Lancet*, 1866, vol. i., p. 340.

proving. The choice then lay between the removal of the dead shaft of the bone at once and expectant treatment. Immediate resection was determined upon, owing to the extreme irritation which the dead bone was producing and the undermining of the patient's feeble powers which would result from extensive suppuration. The operation was performed on April 15th, ten days after admission. A long incision having been made, the finger was passed with extreme ease under the tibia; a chain saw was then conducted round the bone, which was divided. Each fragment was now easily removed by twisting it gently with a strong pair of forceps, and thus the whole diaphysis of the bone measuring $7\frac{1}{2}$ in. was taken out of its periosteal sheath. The boy's general condition rapidly improved—the pulse became stronger, the appetite better, and the pain ceased. A very marked diminution in the length of the limb was discovered about six weeks after the operation; attempts were made to elongate it, but unsuccessfully, and after the boy's recovery $1\frac{1}{2}$ in. of shortening still remained. Mr. Holmes observes that the regenerated tibia was quite as voluminous as the original bone; for, although shorter, it was thicker and of somewhat irregular outline.

Mr. Holmes also removed a portion of the whole thickness of the shaft of the tibia in three other instances,¹ twice successfully, in the other case amputation became necessary.

In Maisonneuve's case,² sometimes quoted as one of subperiosteal resection, the operation differed in nowise from that usually adopted for the removal of an extensive sequestrum. The patient, two years before he came under observation, while engaged in gymnastic exercises met with a severe fall; deep-seated aching pain in the leg ensued, together with general swelling of the limb, and subsequently abscesses; when he came under observation there was copious and fœtid suppuration, enormous increase in the size of the leg, extreme emaciation,

¹ *Surgical Treatment of Children's Diseases*, pp. 393–396.

² *Journal de Médecine et de Chirurgie pratique*, April, 1861.

and hectic fever. Maisonneuve resolved to remove the bone by detaching it from the periosteum. An incision fourteen inches in length, penetrating to the bone, through the periosteum, which was already thickened and lined with a new soft and spongy osseous tissue, was made. The entire shaft of the tibia was mortified, the articular extremities alone remaining healthy. The dead bone was separated from the surrounding structures, and extricated completely, not however without difficulty. An entirely new bone was formed, the restoration being most complete, the formerly diseased leg differing in no respect from the other except in the scar, the only memento of the formidable process through which the patient had passed.

The late Professor Spence published¹ some remarkable examples of subperiosteal resection, where the subsequent repair almost exceeded expectation. Clinically, he thinks there can be little doubt that where a large portion of bone is irrecoverably necrosed the sooner it is removed the better. The cases are of interest from another point of view, as showing the acute nature of some of the inflammatory diseases of bone. In the first, the patient, aged ten, three weeks before admission had been kicked by a horse on his right shin. The leg subsequently became swollen, and two abscesses formed in front of the tibia. These were opened a week before admission, but as profuse hæmorrhage occurred from the periosteal vessels, he was sent to the Edinburgh Infirmary. On admission the tibia was seen white and bare through the incisions which had been made to evacuate the abscess. The boy was very weak and anæmic through loss of blood from the periosteal vessels at time of incision; it was, therefore, thought advisable to postpone operative interference. After a course of tonics for nine days the patient was put under the influence of chloroform and Esmarch's apparatus applied. The two previous incisions were

¹ *Lancet*, Mar. 11, 1876, p. 387-8.

connected, thus exposing the whole length of the shaft of the tibia, which was bare in its entire extent. The periosteum all round the bone was then separated by means of a periosteum scraper, and the entire shaft removed after resection above and below with the chain saw. Scarcely any blood was lost. In two months the new bone felt hard and firm, and had the same shape as the normal tibia. In the second case the shaft of the tibia and most of the fibula were removed. The disease occurred in a girl aged eleven years, and appears to have arisen spontaneously six weeks before admission. A sinus formed at the upper part of the tibia, and a large piece of bare dead bone was seen. Another sinus formed about two inches above the internal malleolus, and dead bone was also felt there. Four days after admission, Esmarch's apparatus was applied, and Professor Spence removed the whole length of shaft of tibia. The cavity was stuffed with oiled lint before the compressure was removed. Subsequently a large abscess formed over the head of the fibula, this was freely opened and a large quantity of pus escaped. A considerable sequestrum of the fibula, nearly its upper third and its head, with articular surface, was removed. Five months later most of the remainder of the fibula had to be taken away. The reproduction of bone in this case was not quite so satisfactory as in the previous one; the leg was, however, quite strong. In the note that followed the relation of these cases, Professor Spence claimed certain advantages for resection in addition to that of shortening the period of treatment. 1st. The early removal of a diseased texture which is injuriously affecting the health and keeping up irritative fever. 2nd. By removal of the diseased shaft to diminish the risk of neighbouring joints becoming affected, and necessitating amputation under most unfavourable conditions. 3rd. Obviating the risk of repeated hæmorrhages from ulceration of enlarged periosteal vessels. The latter advantage can scarcely have much weight, as the

chance of any considerable amount of hæmorrhage such as would endanger life is not a very likely consequence of the disease.

One more interesting case of subperiosteal resection may be quoted, as it shows the amount of bone reproduction twelve months after the operation. Mr. C. Heath¹ showed at the Clinical Society a boy, aged ten, who was kicked on the leg a month before he came under observation. The shaft of the tibia bare, and separated from the epiphysis at each end, was removed May, 1876, by separating periosteum with handle of scalpel. Whole of shaft not removed, back part having new bone adherent to it. Good recovery. Left hospital with an open sinus, and at that time length of limb same as that of opposite side. A year later a quarter of an inch difference in the length of the limbs, due to growth of sound limb.

During the discussion, Mr. H. Marsh referred to a case published by Mr. Vincent, formerly surgeon to St. Bartholomew's Hospital, in which he removed whole bulk of the femur, from trochanter to lower epiphysis, in a child four years old. New shaft quickly developed, with scarcely any shortening.

The cases above quoted from Mr. Holmes and others may be taken as typical of those in which resection is recommended; but it is difficult to understand, from the cases as reported, upon what grounds such severe procedure was undertaken.

Although it is a fact based upon abundant clinical evidence that the removal of a diseased bone is speedily followed by relief of constitutional disturbance, it is a question whether free periosteal incisions with removal of the suppurating marrow through trephine holes, and the subsequent extraction of the dead bone, would not answer the same purpose; the great desideratum is the early recognition of these cases, and the prompt adoption of this or some such simple treatment. The cases in which subperiosteal resection is desirable or necessary constitute, to my mind, a very small minority.

¹ *Trans. Clinical Society*, London, 1877; also *Lancet*, vol. i., 1877.

There is one question in connection with this subject which should not be lost sight of. How far can the periosteum be trusted to reproduce bone of sufficient thickness and solidity? In many cases, no doubt, the new production will serve every purpose; now and again, however, we encounter instances where the new bone thrown out is very imperfect, and totally inadequate to restore the functions of the limb. Such a result happened in a case of extensive necrosis of the tibia, which occurred at the Children's Hospital, Pendlebury, many years ago, where two-thirds of the shaft were subperiosteally resected. Even the transplantation of periosteum only led to a feeble reproduction of bone, and the limb had to be sacrificed at last. Reproduction of the tibia was also incomplete in Letenneur's patient, referred to by Lannelongue. Ollier¹ lays down the rule that if, notwithstanding incisions, the patient is losing strength and is threatened with exhaustion, it is necessary to remove the cause of the suppuration (*i.e.*, the necrosed bone); we should remove the necrosed parts early, if they are injurious, and wait for their separation if they do not occasion any serious inconvenience.

Treatment of General Symptoms.—The general symptoms of acute osteomyelitis, usually at first of an irritative character, soon assume an adynamic form. Lowering treatment, therefore, should be avoided; the patient becomes readily exhausted by the severe constitutional strain, so it is incumbent upon us to husband his strength. As soon as pus is formed, tonics such as iron, quinine, and a generous diet, with possibly the use of stimulants, are urgently needed. Opiates will be necessary to relieve the pain and to procure sleep. Gamet speaks highly of the employment of quinine and digitalis, the first against general infection, and the second as a sedative to the circulation. In the hands of others, however, these drugs have given no satisfactory results.

¹ *Traité des résections et des opérations*, Paris, 1886.

THE RELATION BETWEEN ACUTE OSTEOMYELITIS
AND PURULENT INFECTION.

Some regard the two affections as identical, the bone lesions being merely the local expression of the general blood disease. There can be no doubt this view is an erroneous one. Osteomyelitis is a disease *sui generis*, which may be and frequently is followed by blood infection, the poison being absorbed from the medulla of bones much more readily than from other structures.

It is also asserted that the inflammatory products in marrow suppuration are very liable to undergo septic changes which induce pyæmia. Bruant¹ could only find one case of purulent infection which gave rise to an osteomyelitis. In this connection the researches of Demarquay,² founded upon a large number of cases which he watched during the Franco-German war, are of unusual interest. From post-mortem examinations which he made, he found that whenever during life he had observed symptoms of purulent infection, and after death evidences of that affection, he also saw well-marked osteomyelitis affecting the bones of the broken limbs. Anticipating the objection that this osteomyelitis stands in the same position as the other manifestations of purulent infection (visceral abscesses), he states that the osteomyelitis in all the cases affected fractured or contused bones only, and not those which had escaped violence.

Demarquay also repeated the experiments of Cruveilhier and Ollier, showing the effect of absorption from the medullary canal. Twelve experiments were made on rabbits, from 60 to 120 drops of pus being injected by means of Anel's syringe into the medullary canal of the femur. The same results always followed; the rabbits died between the second and seventh day, after undergoing emaciation, their temperature rising sometimes as high as 41° to 42° C., until just before

¹ Thèse de Paris, 1873.

² *Medical Times and Gazette*, 1871, vol. ii., pp. 414-564.

death. Post mortem there was found more or less phlegmon around the seat of operation, congestion and softening of liver and spleen, and metastatic abscesses in the kidney.

Other experiments showed that absorption from the medulla took place so rapidly that Demarquay was tempted to believe that there must be some direct communication between the medullary canal and the veins of the osseous tissue. Intramedullary injections penetrate into the general circulation like those that are practised in erectile tissues. Eberth¹ considers that in osteomyelitis we have a disease in which there is established in the deeper parts of the bones a process which presents in its course and in its pathological characters a great analogy to pyæmia.

THE RELATION OF BACTERIA TO ACUTE OSTEOMYELITIS.

The first observations on this subject came from Germany. Klebs,² in 1873, showed by experiment the presence of a special organism (*microsporon septicum*) in pathological fluids, and studied its mode of development. He related a case of osteomyelitis arising spontaneously, in which he discovered the spores of an organism which he studied by the cultivation methods now so universally adopted, and described. The following year Lücke³ published his observations on the pus obtained from two cases of acute bone inflammation, where he found a micrococcus both in the primary centre of inflammation and also in secondary centres; this appeared to point to the infectious character of osteomyelitis.

In 1880, Pasteur studied the pus obtained from a case of osteomyelitis under Lannelongue's care. A micrococcus was found consisting of two points placed together—a double microbe—and it was recognised as the one previously described

¹ *Virchow's Archiv*, 1875, Bd. xlv., S. 352.

² *Archiv für exp. Pathol. und Pharm.*, Bd. v., S. 31.

³ *Deutsche Zeitschrift für Chirurgie*, 1874, Bd. iv.

by the German observers. Pasteur cultivated the micrococci and called attention to the resemblance between them and the organisms he had discovered in boils. Thellier¹ refers to a case of acute spontaneous osteomyelitis of the femur, where Nepveu found micro-organisms in the pus at the time of its evacuation.

Becker,² in 1883, published the results of his experiments with the micrococci obtained from a case of acute osteomyelitis. He cultivated them on gelatine and on slices of potato, and states that they are characterised by the orange colour of their colonies and by the peculiar starchy odour of the cultivations when exposed to the air; to the organism he gave the name *staphylococcus pyogenes aureus*. With his cultivations he made many experiments, and found that intravenous injections containing the micrococci produced a fatal result with osseous supuration whenever there existed a fracture or contusion of bone.

Rosenbach³ confirmed Becker's conclusions in regard to the peculiar colour of the cultivations, and in addition to the *staphylococcus pyogenes aureus*, he described another microbe which differs from the former by the absence of colour in its colonies—*staphylococcus pyogenes albus*. Krause⁴ also confirmed the foregoing experiments, and concluded that in the acute osteomyelitis of man there exists a micrococcus which when introduced in sufficient quantities into the blood-vessels of rabbits produces an acute infectious disease which invariably terminates fatally; and furthermore that this disease has a peculiar tendency to attack the joints, bones, and muscles.

Rodet⁵ obtained in animals a condition similar to osteomyelitis in the human subject, and concluded that osteo-

¹ De l'ostéomyélite spontanée considérée dans son étiologie et sa pathogénie, Thèse de Paris, 1883.

² *Berliner klin. Wochenschrift*, Dec., 1883.

³ *Centralblatt für Chirurgie*, 1884, No. 5.

⁴ *Fortschritte der Medicin*, April, 1884.

⁵ *Revue de Chirurgie*, April and August, 1885, pp. 273-287, 636-663.

myelitis is due to a microbe. At present, however, the state of our knowledge hardly warrants us in saying that the microbes discovered in acute bone inflammations are specific germs, for organisms most closely resembling them are found in other diseases besides osteomyelitis.

Krause and Pasteur found them in the discharge from boils; Garre¹ met with them in several suppurative diseases—boils, phlegmon, and whitlow; while Rosenbach regards the micrococcus as the common microbe of pus. The pus of boils contains a microbe which appears to be absolutely identical in its properties and physiological effects with that of osteomyelitis, so that some have regarded the two diseases as being produced by the same agent. Garre has endeavoured to show this by experiments upon himself; with the microbe of osteomyelitis he induced boils; while Rodet has shown the converse, and has induced osteomyelitis with the micrococcus of boils.²

¹ See abstract *Medical Chronicle*, Sep., 1885.

² Some later observations on the etiology and pathogenesis of acute osteomyelitis will be found in a paper by Professor Kraske, *Archiv für klin. Chirurg.*, 1887, Bd. xxiv., S. 701. Professor Kraske concludes that acute osteomyelitis in man may be produced by the staphylococcus pyogenes aureus alone; that when other micro-organisms, such as staphylococcus pyogenes albus, streptococcus pyogenes, and bacilli, are found, it indicates the peculiar severity of the affection, and that it is possible any pathogenic micro-organism may cause typical osteomyelitis in man.

CHAPTER V.

OSTEOMYELITIS (OSTEITIS) OF THE SHORT AND FLAT BONES.

Acute inflammations attack these bones much less often than the shafts of long bones. Among the short bones the disease has been observed in the os calcis, patella, the vertebrae, in which situation it is a probable origin of Potts' disease (Lannelongue), and in the bones of the cranium. When osteomyelitis attacks any of the bones of the tarsus or carpus, it readily spreads to the articular ends of these bones, and sets up a suppurative inflammation, which rapidly spreads to neighbouring tendinous sheaths. The amount of mischief thus set up in the soft parts is very considerable, and it usually extends some distance beyond the original focus of disease.

The affection is in many cases induced by an injury, which is followed by a pain varying in intensity, disappearing for a day or two and even longer, to return with increased severity. The pain is usually acute, spontaneous, seriously aggravated by pressure and every attempt at moving the part, it may become exceedingly violent, interrupting or even preventing sleep, and associated with it are severe general symptoms, strongly suggesting the grave character of the affection. A fresh local symptom, a diffuse oedematous swelling, usually soon shows itself, which is quickly followed by acute suppuration.

Lannelongue¹ records a case of osteomyelitis of the second lumbar vertebra, where a few days after the commencement of the disease a dilated venous network appeared under the skin of the lumbar region; this symptom, combined with severe

¹ *Loc. cit.*, case xxi., p. 155; also *plate I.*

constitutional disturbance, induced Lannelongue to suspect a lesion of the vertebral column, which supposition proved correct on post-mortem examination.

A case similar in many respects to this came under my care at the Infirmary at the beginning of the year 1886. Here the disease occurred in a girl aged seven years, and involved the upper dorsal vertebræ; the general symptoms were very acute; a large swelling covered by numerous veins appeared, gave way and discharged profusely. The disease proved fatal within two months of its onset; in this respect and in the severity of its symptoms forming a marked contrast to the ordinary course of disease of the spine.

As regards pathological anatomy and tendency to pyæmic complications, osteomyelitis of the smaller bones differs in no wise from the same disease in the shafts of the long bones. The indications for treatment are also similar, and the rules already laid down have to be observed. Early incisions to liberate the subperiosteal collections of pus rarely suffice. Trephining the bone is often insufficient; and complete removal of the diseased bone or amputation of the limb should be adopted before grave complications have arisen.

Osteomyelitis attacking the cranial bones is a very serious affection, in consequence of the implication of the cranial contents. The disease in most instances rapidly extends inwards and quickly produces a fatal issue. I had an opportunity of seeing an example of the disease arising spontaneously, and involving the frontal bones, in a lad about seventeen years of age, whom I saw with Mr. Smart. The disease commenced with pain in the forehead, quickly followed by diffuse œdematous swelling, soon ending in suppuration. Within three days of the onset incisions were made, allowing an unusual quantity of an offensive pus to escape from beneath the periosteum, and disclosing bare bone. Symptoms of a typhoid character rapidly set in. Little or no improvement followed the evacuation of the matter, and the disease proved fatal in about a week.

There were signs of pressure on the brain two days before death; no post mortem was made, but there can be little doubt that the disease had extended inwards and produced on the inner surface of the vault a condition similar to those observed on the outside.

In a case recorded by Chippault,¹ half the frontal bone was separated from the periosteum by a layer of pus, and a separation having almost exactly the same limits existed on the inner surface, where the pus formed a greenish mass. On the exterior the bone presented a number of irregular orifices through which drops of pus exuded from the diplöe. The brain showed no change, but the arachnoid surface of the dura mater was thickened and covered by easily separable layers of pus. In Crampton's² case a layer of pus was spread underneath the periosteum, covering the anterior portion of the frontal bone, descending as far as the upper margin of the orbit, and extending backwards towards the temporal region. The dura mater was separated to a slightly less extent, and purulent lymph covered it. The brain was congested.

The diagnosis is not difficult when the disease attacks one of the bones forming the vault; the severity of the general symptoms, and the rapidity with which the local phenomena declare themselves, will be sufficient to indicate the grave character of the affection which almost invariably proves fatal.

The subpericranial abscess usually has a purulent collection corresponding to it on the inner surface of the bone affected, the latter should be trephined and the intracranial abscess evacuated. This operation is indicated whenever the symptoms denote severe bone inflammation, and as soon as an abscess has formed beneath the pericranium. Happily the prognosis in osteomyelitis of other flat bones is not so unfavourable.

¹ *Bulletin de la Société Anatomique*, 1863.

² *Dublin Hospital Reports*, vol. xi.

OSTEOMYELITIS (OSTEITIS) OF THE ARTICULAR
EXTREMITIES OF LONG BONES.

This affection is intimately connected with the important subject of joint diseases. The medulla filling the areolæ of the spongy tissue is the real seat of the inflammation, in it we have increased vascularisation with exudation, and in this condition the part may remain for some time. In many instances pus is formed from the vascular medullary tissue, and the trabeculæ, which at first maintain their structure, not unfrequently necrose. A line of demarcation is formed between the dead and living portions, where a pyogenic membrane is constructed, and after the sequestrum has been got rid of, the suppuration ceases and new osseous tissue is produced to replace the lost part. Unfortunately, while these changes are going on in the epiphysis, the neighbouring articulation often becomes implicated in the diseased process; this constitutes an additional anxiety, and often produces an unfavourable result.

The symptoms of articular osteitis are very similar to those indicating bone inflammation—deep-seated pain, usually of a dull, aching character, a moderate swelling, at first confined to the locality of the disease, afterwards becoming more diffuse, especially if the disease involves the adjacent articulation.

Should the disease undergo resolution, the pain subsides, and even where hyperostosis results it is rarely appreciable, the hardening being the result of trabecular hypertrophy, which may exist without any external evidences. On section it will be seen that the interstices of the spongy bone tissue are encroached upon by condensation and thickening of their walls.

The symptoms associated with suppurating osteitis of the epiphyses bear a strong resemblance to those connected with osteomyelitis of the diaphyses. The exact position of the disease determines the direction the suppuration will take. When

bordering on the encrusting cartilage, the matter often finds its way into the adjacent joint; examples of destruction of the knee joint following the escape of matter into it, either from the articular end of the tibia or femur, will be familiar to every one. It is not necessary that the focus of disease in the epiphysis should communicate directly with the articulation before a destructive arthritis is set up. This may result from contiguity of the suppurative inflammation alone. When the disease is situated near the diaphysial line, the suppuration extends outwards and the abscess gives way externally, thus diminishing the chances of joint implication.

The treatment differs in no wise from that already indicated as applicable to acute osteomyelitis. If with rest and ordinary means the inflammation does not subside, the necessity for perforating the bone will become evident, and the timely adoption of this plan often obviates articular involvement.

ACUTE OSTEITIS (OSTEOMYELITIS) OF UPPER END OF TIBIA; TREPHINING;
CURE.¹

Case 5.—Mary M., aged nineteen years, admitted into the Manchester Infirmary, September, 1881, complaining of intense pain in the left knee, which was much swollen. Causation of the disease obscure. The patient is a servant, and while at her work has to kneel a great deal. A few days before admission she was suddenly seized with a very acute pain in her left leg immediately below the knee, which soon became swollen. Examination of the limb showed effusion into the knee joint and an ill-defined doughy swelling below the articulation. The gentlest manipulation induced an agonising pain and intense dread. Pressure detected an exquisitely tender spot over the inner tuberosity of the tibia, while in other situations the discomfort was not materially increased by the examination. There was in addition very decided fever, and the general symptoms indicated much suffering. The limb was placed on a back splint and lead and spirit applied, while the pain was relieved as much as possible by means of opiates. At first there were some indications of improvement, the pain decreased and the general condition amended slightly. Soon, however, the paroxysms of pain became more frequent and pronounced and the nights were very much disturbed. An incision was made through the soft structures and periosteum covering the most painful part of the tibia; no relief followed. A few days later a small trephine was employed and a circle of bone removed from the tibia at the spot where the pain was most severe on pressure. The cancellous structure was found infiltrated with inflammatory

¹ The first case in which I trephined for acute inflammation of bone.

products, and at one part of the circle there was a black spot composed of extravasated blood. This appeared to be the focus of disease, and no doubt in the course of a short time there would have been an abscess in this situation. The relief experienced by the patient after the operation was most gratifying and satisfactory, the pain instantly and completely disappeared. Convalescence was somewhat delayed by suppuration which occurred on the inner side of the knee. Eventually the patient made a good recovery, but there remained partial ankylosis of the knee joint, owing to the close proximity of the disease to the articulation. In all probability had the disease been allowed to progress unchecked, the joint would have undergone suppurative inflammation, a condition fraught with the most disastrous consequences.

SUBACUTE OSTEOMYELITIS OF HEAD OF TIBIA; SECONDARY SYNOVITIS;
PERSISTENT PAIN IN THE BONE; TREPHINING; CURE.

Case 6.—Annie W., twenty-four years of age, one of the nurses at the Infirmary, admitted as a patient June, 1884. In carrying a child across the ward she fell, injuring her right knee. A swelling very soon appeared around the joint, together with some discolouration and pain. The limb was placed on a straight back splint and lead and spirit lotion applied to the part. This treatment was continued for two months, at the end of which time Scott's dressing and a Martin's rubber bandage were applied. As this rather increased the pain and discomfort it was removed and the knee blistered. Later the limb was put in an immovable apparatus, which remained on about a fortnight, but had to be taken off because of the increasing swelling of the joint. More blisters were applied, which materially reduced the effusion; the pain, however, continued. Some relief of a temporary nature was obtained from the application of the actual cautery. Various other medicaments were tried with the hope of subduing the pain, which, however, remained unrelieved. On 20th June, 1885, about twelve months after the accident, the report states "that the patient's knee is still swollen, the patella is movable, but pressure over it occasions a great deal of pain. The knee is quite straight but perfectly rigid. Over the inner tuberosity of the tibia there is a circumscribed area in which there is almost constant aching and where pressure produces severe pain." This appeared to be the seat of disease, and as the remedies hitherto employed had proved useless it was proposed to perforate the bone at this spot. To this proposal the patient readily assented; indeed to obtain relief she was quite willing to submit to amputation. She was anæsthetised and an incision made on the inner surface of the knee, opposite the tuberosity of the tibia and parallel with the long axis of the limb. On reaching the periosteum that membrane was found thickened and infiltrated. A crucial incision was made in it and it was detached from the subjacent bone; the latter presented a very vascular appearance; a small circle was now removed with a trephine $\frac{1}{2}$ in. in diameter, and in doing so some oily fluid escaped. The circle of bone was very soft, and at one part presented distinct evidence of inflammation, being of dark colour and infiltrated. Some soft bone was removed with a Volkmann's spoon, the cavity plugged with iodoform gauze, and a wood-wool dressing applied. The limb was at the same time placed on a straight back splint. The peculiar gnawing, wearing bone pain immediately subsided. It is true that for a few days she experienced a little occasional aching in the limb, but

this was totally unlike what she had suffered before. The nights which before the operation had been disturbed were now free from startings, the general health soon began to amend, and the swelling about the knee joint which had existed uninterruptedly since the accident also subsided. She spent some weeks at the Convalescent Home, at Cheadle, and afterwards returned to her duties at the Infirmary. The knee is now quite movable, and the pains and aches have completely disappeared. The results obtained by the trephine in this case were unmistakable and highly gratifying.

THE REMOTE EFFECTS OF OSTEOMYELITIS DURING THE GROWING PERIOD; CHRONIC AND PROLONGED OSTEOMYELITIS.

The protracted consequences induced in a bone attacked with acute inflammation while growth is in progress, were very imperfectly understood until the researches made by Lannelongue and Comby.¹ It was supposed that death or recovery ensued after a more or less prolonged suppuration and expulsion of sequestra. No one it seems had observed the diseases which may attack a bone predisposed by a first attack, the form, the size, and blood supply of which had been seriously modified by the primary acute inflammation. So that when a bone so changed became the seat of disease, this was regarded as a new and independent affection, and the close connection between it and the deeply-seated initiative disturbances, relics of the long-forgotten osteomyelitis, was not discovered.

Now it is known that the osteitis or osteomyelitis of adults is usually a continuation of an inflammatory disease which attacked the bone during infancy or early adult life. Gosselin² alludes to the epiphysial osteitis of adolescents as being the frequent cause of necroses of spontaneous origin. Trélat mentions the case of a man, whose thigh he amputated for a chronic disease of the femur, which had been in a process of evolution for more than forty years, and the origin of which was a suppurative osteomyelitis.

¹ *London Medical Record*, vol. x., 1882, p. 400.

² *Nouveau Dict. de Méd. et de Chirurgie*, Art., Os.

Lannelongue and Comby were the first to establish the relations of cause and effect, which frequently connect osteomyelitis with a series of affections of bone which were formerly supposed to be all but independent. They have proved in a perfectly satisfactory manner that many chronic affections, such as hyperostosis with bone abscesses, are the result of a disease long since forgotten until special inquiry elicits the fact.

I will give the history of a remarkable example illustrating this fact in the patient's own words. At the age of seventeen, in trying to correct some defective machinery, H. E. ran over the tops of some sheet glass crates, when some of the top rails broke, and falling sideways he struck his left thigh against the side of a crate. He thought little of the accident at the time, and resumed his occupation, which, however, he was compelled to discontinue, owing to a feeling of malaise. He did not experience any pain in the thigh for several weeks, still he was in a condition of ill-health which nobody could well define. He was then seized with a severe pain in the thigh, which had been previously injured. The pain, which he described as dull and aching, occasionally became very violent, and appeared to extend from the hip to the toes. About this time he consulted several medical men, who explained his symptoms in different ways, and he was advised change of air. On the night before starting he had a severe burning pain in the thigh, and at the same time a red spot appeared on the lower and inner aspect of the limb, where very soon afterwards an abscess developed. This discharged for several months, then healed, and he naturally thought his troubles were over. He was now engaged as a commercial traveller, and accomplished a great deal of work, could walk briskly and run without any inconvenience. About eighteen months later he again began to ail, and felt as though the old complaint was about to return; in about two months, with rest and a fortnight at the seaside, his troubles disappeared

once more, and he regained his normal state of health. For about nine years he remained in much the same condition; then he began to lose weight and energy, and to experience a pain in the left knee, which however only troubled him when he walked up or down stairs; while on the level ground he felt no pain. Another symptom which he noticed was an unusual tendency to become fatigued from slight exertion. At this period he was treated for rheumatism; he painted the joint with iodine and enveloped it in flannel. He obtained no relief; the pain varied, sometimes it would be very acute and make him quite lame and totally unfit for any work. He now came under the care of another surgeon, who at once suspected the connection between his then symptoms and the old bone disease which was supposed to have subsided many years ago. In confirmation of this view, there was a very large amount of thickening confined to the lower third of the thigh. With rest at the seaside some improvement became apparent in his condition; he was able to return to his work, still he was not free from occasional attacks similar to those before mentioned. Things became much worse at the beginning of 1883, eighteen years from the date of the accident, the pain assumed a more persistent and severe character, occasionally agonising in its severity; the thigh also became more swollen and tender to the touch; the excruciating pain commenced about midnight, and was apparently seated in the knee joint.

About this time he entered the Manchester Infirmary and came under my care. There was acute suppuration of the knee joint, with immense thickening extending upwards to the middle of the thigh; the gentlest manipulations induced the greatest agony. From the history we concluded that the *fons et origo* of the whole morbid action was in the interior of the lower part of the femur. The man's general condition and his intense suffering required that some immediate relief should be obtained, and as nothing short of amputation promised to be of any service, the limb was removed by flap

operation about the middle of the thigh. Where the bone was sawn through it was found to be very thick, sclerosed, and there was almost total obliteration of the medullary canal (*fig. 11*). The patient made a rapid and perfect recovery, remains in good health, and is able to walk well with the aid of an artificial limb.

When making a section of the amputated portion of the femur, a large quantity of very thick, foetid pus escaped from a cavity in the lower end. Within the thick, dense structure of each half of the femur there existed several cavities containing caseous masses which appeared to be degenerated pus, evidently the result of the inflammation which had existed

FIG. 11. ✓

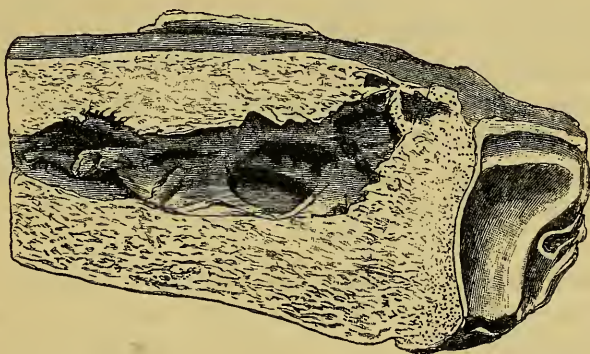


FIG. 11.—Cavity in lower end of femur; acute attack of osteomyelitis eighteen years previously (*O. C. Museum*).

many years previously. That the appearances shown in the woodcut (*fig. 11*) were not due to any recent affection is made tolerably certain by the condition of the bone which surrounded each little cavity; it was immensely hyperostosed, presenting a firm, ivory-like appearance, with no indication of ordinary bone structure to the naked eye.

This case furnishes us with a typical picture of a disease which had been in progress for many years. It may be classed among the cases of prolonged osteomyelitis, instances of which

have been from time to time published since attention was directed to the disease by Lannelongue and Comby. There can be no doubt that the symptoms which the patient details indicated the presence of a change which, on account of acute recrudescence, threatened speedily to destroy life if the limb was not sacrificed.

Verneuil¹ made an interesting communication to the Société de Chirurgie respecting the late results of the osteomyelitis of adolescents. A patient at the age of nineteen submitted to amputation of the thigh in the middle third for an epiphysary osteitis of the femur. The treatment did not arrest the course of the disease, which continued to trouble him until he was fifty-three years of age. When the patient came under observation he was in a state of chronic septicæmia; the stump was covered with cicatrices and fistulous openings, none of the latter leading down to the bone, the hyperostosed femur could, however, be easily felt. A new abscess formed, which aggravated the patient's condition and induced Verneuil to amputate, which he did through the upper third of the thigh immediately below the trochanters. The patient recovered.

Lannelongue and Comby in their paper publish thirteen cases that have come under their observation, or which they have collected from various sources, showing the presence of hyperostosis in the short and flat bones as well as in the long bones. The primary disease was sometimes of from ten to twenty years' standing. The practical outcome of these observations is that when, at any period after the completion of growth, we find thickening of a bone, associated with elongation of the limb, chronic arthritis, or ankylosis, we must consider whether we are not dealing with the consequences of a prolonged osteomyelitis. The following among other cases which have occurred in my practice bring out prominently this

¹ *Le Progrès Médical*, 1884, p. 993.

relation, which has been insisted upon above, of an exacerbation, which must be regarded as the recrudescence, of a long pre-existing inflammatory process:—

PROLONGED OSTEOMYELITIS; CAVITY IN LOWER END OF RIGHT FEMUR, CONTAINING OFFENSIVE MATTER AND BONE DETRITUS; TREPHINING AND DRAINAGE; SUBSEQUENT AMPUTATION; RECOVERY.

Case 7.—H. S. B., aged thirty-five years, admitted into the Manchester Royal Infirmary, February 2nd, 1885. About the year 1862, when patient was thirteen years of age, he had what was considered to be rheumatic fever, but no other joint than the right knee, which is the anchylosed one, was affected. After the inflammation in the joint and the fever subsided he had a stiff knee, without much pain; and he was able to walk fairly long distances. An abscess formed and discharged for about a month after the fever had left him. Ever since a sinus has existed on the inner side of the right thigh, a little above the internal condyle. He attributes the original attack to cold. From time to time small sequestra have worked their way out, and about a year ago the patient himself removed a shell of dead bone some three inches in length. The man presented a pale, sallow, unhealthy appearance—the effects of chronic septicæmia. His right knee is stiff, and together with the lower part of the femur forms a hard unyielding swelling, which terminates rather abruptly about the middle of the thigh. On the inner aspect is a sinus surrounded by nipple-like granulations, which leads directly into a large cavity containing some dead bone. The discharge is abundant and exceedingly offensive; it is this circumstance chiefly which has induced him to seek relief. The limb is painless and useful. A few days after admission an opening was made into the cavity by chiselling away some hard new bone on the outer side of the thigh at a spot opposite the sinus on the inner aspect. By this means it was hoped that the large cavity would be more efficiently drained. Its lining membrane, consisting of stinking granulations, was removed at the same time, also some porous sequestra. A large drain tube was inserted and brought out on each side. A carbolic solution (one in twenty) was employed for washing out the cavity, and iodoform was insufflated. Notwithstanding this the discharge continued to be very foul, although the quantity diminished in some degree. Subsequently the cavity was attacked from the front, an opening being made into it in this situation. No improvement followed. The patient now became anxious that a radical measure should be adopted, as the foulness of the secretion from the cavity was becoming a source of anxiety to him in respect of his occupation, his fellow clerks showing signs of resenting his presence. At this time I had no knowledge of Neuber's method of dealing with bone cavities, so there appeared no alternative but to resort to amputation. This was accordingly done, and the patient made a rapid and excellent recovery. The femur, where it was sawn through, consisted of a solid cylinder of bone (*fig. 5*), measuring two and a half inches across; no trace of a medullary canal could be discovered. The pathological condition did not in any way disturb the healing process, the stump cicatrising soundly in less than three weeks.

CHRONIC INFLAMMATORY DISEASE IN THE RIGHT FEMUR; SUPPURATIVE ARTHRITIS OF THE KNEE JOINT; AMPUTATION OF THIGH; RECOVERY.

Case 8.—T. W., forty-four years of age, admitted into the Manchester Royal Infirmary, January 2nd, 1884. When patient was fourteen years old he had an attack of pain with stiffness in the right knee, accompanied with considerable swelling. An abscess formed and discharged, and through the resulting sinus there escaped a small splinter of necrosed bone. The attack, probably produced by a cold, lasted about six months, and with the exception of some rigidity of the knee joint, he recovered and remained well until four years ago. At that time he again complained of pain about the knee, soon followed by swelling and increased stiffness. As these symptoms continued he attended as an out-patient, and had lin. iodi. applied to the affected part; an improvement in the condition of the knee followed, and he was able to resume his employment. A second attack of a similar character occurred six months before admission, and at this time an abscess formed and gave way on the outer side of the knee. On examining the thigh we found a firm thickening of the femur, which terminated rather abruptly about three inches above its lower extremity. On the outer side were two openings leading to a sinus which extended for two or three inches along the femur on its outer surface. While the patient was under the influence of chloroform the thigh was explored and bare bone detected, but nothing in the shape of a sequestrum was met with. The sinuses were scraped, the wound drained, and dressed with oiled lint. A few days later a fluctuating swelling appeared on the inner aspect of the knee; this was incised and a large quantity of pus allowed to escape. As things did not improve, and as there was some evidence to show that the knee joint was seriously compromised in the disease which had attacked the femur, amputation was advised. The operation was done through the middle third of the thigh by a long anterior skin flap, and a shorter posterior flap made by transfixion; the femoral artery was torsioned and the other vessels ligatured. The portion of femur removed was found to be sclerosed, the lower third having been converted into a solid rod of dense bone, there was very little difference between the cortical and central parts; at the point of section the bone was much sclerosed, the cortical part greatly increased in thickness, the medullary canal narrowed and filled with a soft vascular tissue, the cartilages of the knee joint softened and eroded at their edges, synovial membrane thickened and pulpy. The subsequent course of the case was satisfactory, the temperature remained near the normal throughout, and the wound healed with scarcely any suppuration, and this exclusively in the course of the drainage tubes, union by first intention everywhere else. On one occasion the temperature suddenly rose to 101° ; this was due to some pent up pus, and on its evacuation the fever quickly subsided.

PROLONGED OSTEOMYELITIS OF THE TIBIA; SUPRACONDYLOID (STOKES') AMPUTATION OF THE THIGH; RECOVERY.

Case 9.—R. S., aged fifty-six, admitted into the Manchester Royal Infirmary, June, 1885. Nearly fifty years ago—that is, when he was about six years of age—he suffered from acute inflammation in the right leg, which has been the seat of a diseased bone ever since. He has been an in-patient at the Infirmary on several occasions, in order to have some fragments of necrosed bone removed. There is a

large ulcer on the right tibia; it is about five inches long by three broad, and its lower end is just above the ankle. The edges of the ulcer are hard, thick, and ragged, the inner one being greatly thickened; its floor is very uneven and hard. The surface secretes freely, the discharge being abundant and offensive. The man was thoroughly tired of his limb, and as several operations had been performed without producing a cure he was anxious to have it removed. This was done through the lower part of the thigh by Stokes' method of amputation. The patella was retained against the sawn surface of the femur by catgut sutures passed through the ligamentum patellæ and the tissues at the back of the femur. A rapid recovery followed. There is one very important point to be mentioned in connection with this case. Although suppuration had continued for the unusually long period of nearly fifty years, no evidence existed of amyloid or any other change in the kidneys, liver, or spleen, the man throughout retaining a fresh complexion and a good state of health.

ACUTE OSTEOMYELITIS IN THE ADULT.

As already stated, the idiopathic form of acute osteomyelitis is rarely seen after twenty-five years of age. From this it must not be concluded that the disease never attacks individuals bordering on middle age and beyond, otherwise serious mistakes in diagnosis will inevitably arise.

I have already described¹ a typical example of the affection, arising spontaneously in the femur, in a man thirty years of age, where recovery followed amputation at the hip joint. Chassaignac mentions one at the age of thirty-five, and Lemoine in his thesis² has collected twenty-one cases of osteomyelitis and phlegmonous periostitis in adults. In one, a woman fifty-three years of age, the symptoms were so insidious at the onset that an osteo-sarcoma was suspected, and not until after the lapse of two months did the diagnosis of osteomyelitis become absolutely certain; the general symptoms aggravating from day to day, the thigh was amputated, and on examining the limb the knee was found to be full of pus and the medullary canal of the tibia formed a larger purulent cavity.

We are fully justified in concluding from published cases that

¹ *Medical Chronicle*, Nov., 1884.

² Thèse de Paris, 1885. Billroth (*Chir. Klin.*, 1867, p. 417, Berlin, 1869) mentions a case of acute periostitis and osteomyelitis of the humerus in a man aged seventy. No cause could be assigned; the disease terminated fatally.

acute suppurative inflammation of both periosteum and medulla does occur in adults long after growth is complete. That the symptoms of the disease are identical in children and adults. That the work of repair is accompanied by excessive bone formation more often in children than in adults. And that the prognosis in acute bone disease is much more grave after twenty-five than at a younger age, and the issue of osteomyelitis more serious than that of phlegmonous periostitis.

CHAPTER VI.

CHRONIC CIRCUMSCRIBED SUPPURATIVE OSTEO-MYELITIS.

Syn. ABSCESS OF BONE.

This disease was described by Brodie,¹ in 1845. A mistaken diagnosis led to a discovery which was afterwards turned to good account. A young man, aged twenty-four, consulted Sir Benjamin Brodie in 1824 under the following circumstances: There was a considerable enlargement of the right tibia, extending to a distance of two or three inches from the ankle joint. The integuments were tense and adhered closely to the surface of the bone. The patient complained of a constant pain, referred to the enlarged bone and neighbouring parts. The pain was always sufficiently distressing, but he was liable to more severe paroxysms, in which his sufferings were described as most excruciating. These paroxysms occurred at irregular intervals, confining him to his room for many successive days, and being attended with a considerable degree of constitutional disturbance. The disease had existed for more than twelve years, and had rendered the patient's life miserable during the whole of that period; various modes of treatment had been resorted to without any permanent advantage, and the remedies which Brodie prescribed were equally inefficacious. Finding himself without any prospect of being relieved by other means, the patient made up his mind to lose his limb by amputation. This operation was performed accordingly.

On examining the amputated limb, it was found that a quantity of new bone had been deposited on the surface of the

¹ *London Medical Gazette*, December 12th, 1845, p. 1399.

lower extremity of the tibia. This was the result of periostitis. The whole of the lower extremity of the tibia was harder and more compact than under ordinary circumstances, in consequence, as it appeared, of some deposit of bone in the cancellous structure. In its centre, about one-third of an inch above the ankle, there was a cavity the size of an ordinary walnut filled with dark-coloured pus (*fig. 12*). Brodie adds these

FIG. 12.



FIG. 12.—Chronic circumscribed suppurative osteomyelitis in lower end of tibia (*Brodie*).

significant words, which foreshowed the treatment which has been on many occasions since successfully carried out: "Had the exact nature of this disease been understood, and the bone perforated with a trephine so as to allow the pus contained in its interior to escape, a cure would have been effected without loss of limb, and with little or no danger to the patient's life."

Nor had he to wait long before an opportunity offered for putting his newly-acquired knowledge into practice. Two years later a patient, aged twenty-three, with similar symptoms,

presented himself. The first diagnosis made was chronic periostitis; and in order to relieve the pain an incision through the periosteum and the subjacent new bone was made. The symptoms at once disappeared, and it was supposed that a cure had been effected. The thickening of the bone did not, however, subside. The patient again came under treatment at the end of two years; he was now quite unable to walk and totally unfit for his ordinary occupation. The pain was constant, but more severe at one time than another, and often prevented sleep during several successive nights. The patient's condition demanded immediate relief. The great similarity between the symptoms in this case and the preceding one were too manifest to be overlooked.

Trephining was therefore proposed, and the operation readily assented to. A circle of bone extending into the cancellous structure was removed, but no abscess discovered, several pieces of bone were then removed by means of a chisel. As this part of the operation was proceeded with, the patient suddenly experienced a sensation, which he afterwards described as being similar to that which is produced by touching the cavity of a carious tooth, but much more severe, and immediately some dark-coloured pus was seen to issue slowly from the part to which the chisel had been last applied. From this time the peculiar pain belonging to the disease entirely ceased and never returned. The particulars of this case have been given at some length because it may be regarded as among the first in which an accurate diagnosis was made, and where the trephine successfully evacuated a chronic abscess from the interior of a long bone.¹

Symptoms.—There are three principal symptoms which mark the presence of pus within a bone; they are pain, swelling, and the chronic character of the disease. The pain is of a dull, wearing character, deep-seated, intermittent or con-

¹ The operation was performed in 1827, and the case with others was referred to in a clinical lecture delivered at St. George's Hospital, November 19th, 1845.

tinuous, with an increase in its intensity at variable intervals. There is a general enlargement of that part of the bone which is affected, with thickening of the soft parts covering it, and periosteal tenderness on pressure, with exquisite sensibility over a limited area, which usually indicates the position of the abscess.

The pain is seldom altogether absent, and the increase in its intensity is ushered in, in a very characteristic way. In the greater number of cases the exacerbation commences during the afternoon or evening, remains for a considerable period, often eight or ten hours, then it subsides and often almost completely disappears, to return again after an interval which may be days, weeks, or even months. The pain increases with exercise, subsiding again with rest. In a certain number of cases this peculiar pain of bone abscess may be present and yet be dependent upon other causes. Tenderness is frequently an important symptom in bone abscess; in addition to the diffused sensitiveness over the diseased part, there is a more constant and greater tenderness at one spot; and in this situation, on pressure, the patient experiences an acute pain, which is generally an important guide to the position of the abscess.

The enlargement consists for the most part of thickened periosteum, with some swelling of the superficial structures, which become puffy and inflamed when the pus is making its way to the exterior. The amount of external induration and swelling will depend upon the degree and extent of the periostitis; this may be only very slight when the disease is merely an abscess. The disease is usually situated in the articular extremity of a long bone, and occurs most frequently in the male sex, and during the period of growth or in early adult life. Among the morbid conditions producing an uncertainty regarding the diagnosis are condensing osteitis, intraosseous growths (myeloid, central enchondroma, cystic and hydatid disease).

An abscess may form in any bone and in any part of a bone; it is, however, much more common in the articular extremities of cylindrical bones, and only occasionally observed

in their shafts. The parts most commonly affected are the lower end of tibia, upper end of same bone, and the lower extremity of the humerus. The size of the abscess cavity will mainly depend upon the duration of the disease and the extent to which the bone has been hollowed out by the pus contained within it. The cavity is lined by a pyogenic membrane resembling in appearance that which lines the parietes of abscesses in other textures of the body.

The duration of the disease is very variable. Usually the history extends over several years, and if during the latter part of this period the symptoms, especially the pain, are persistent and well marked, we shall have good grounds for coming to a definite conclusion in regard to the existence of an abscess. We are not to conclude there is no abscess when the pain is not constant; in some instances a real intermission of several months has been observed.

What becomes of a bone abscess if left to itself? After a lengthened period of more or less constant suffering, during which the neighbouring articulation (the disease being, as is generally the case, in the articular end of a bone) is not unfrequently the seat of recurring attacks of inflammation which subside under rest, the matter may find its way to the surface, as in an ordinary abscess, the pus being discharged through a fistulous channel in the bone and soft structures; or a worse thing may happen—the pus may burst into the joint, which has been a source of constant anxiety, where it induces destructive inflammation with its serious consequences. The rule in abscess of bone, as in that in other tissues of the body, is that it tends to expand in the direction in which it meets with least resistance.

Treatment.—Undoubtedly the most efficient method of dealing with a bone abscess is to open it with a trephine or with a fine saw. The operation produces an equally good effect in chronic and neuralgic osteitis, a condition so constantly and in many cases unavoidably mistaken for bone abscess. Before

employing the trephine, it may be deemed advisable to adopt the ordinary method of treatment for chronic periostitis; still too much time must not be spent in administering such drugs as iodide of potassium, perchloride of mercury; or in the local application of blisters.

Incisions through the soft parts, including the periosteum, affording no relief, there is no alternative but to perforate the bone. Surgeons in the time of John Hunter and long anterior to that period employed the trephine in cases of suppuration in bone. The operation was advocated even by Celsus and by Severinus, also by Heyne and Petit. In America it was done by Walker, of Virginia, as early as 1757, and later by Professor N. R. Smith. Hunter¹ told his class, in 1787, "that the potential or actual cautery or the crown of the trephine are often necessary to be employed in order to get at the seat of an abscess in bone," and spoke as if the operation at that time were recognised and often practised. The operation fell into disuse, from what cause it is difficult to understand, probably owing to the difficulties attending the diagnosis and the fear the surgeon entertains that if he does not find pus some harm will have been done. The credit of reintroducing the practice is generally ascribed to Sir Benjamin Brodie, who first performed the operation in 1827.

The operation is performed in the following manner: the limb is rendered ischæmic by Esmarch's bandage and the bone exposed by incising the structures covering it. The chief seat of pain in the bone is to be exposed for the application of the instrument. The periosteum may be divided crucially and turned back, or removed with the small circle of bone. The trephine in its course will traverse in some cases thickened and more or less sclerosed bone, and in others bone that has become soft and atrophied. The former condition occurs in cases where the disease has lasted some

¹ Hunter's MS. Lectures, 1787.

length of time and where a spontaneous cure is almost or quite impossible ; the latter in cases of recent subacute inflammation, where the pus may find a way to the exterior through gradual medullisation and perforation of the bony wall. While this natural process of cure is taking place, the patient endures much unnecessary suffering that might at any time have been relieved by a simple operation which is attended with scarcely any risk. In eight out of nineteen cases submitted to operation Ollier found pus. In all the type and character of the pain at once changed ; the nocturnal attacks of deep-seated and lancinating anguish were replaced by a feeling of uneasiness in the wound, which gradually ceased ; of the nineteen cases two proved fatal from pyæmia.

Brodie counsels the surgeon to provide himself with a proper trephine, which should be one without a shoulder or rim, so that the instrument can penetrate any depth of bone. Mr. Erichsen¹ thinks that two instruments of the same size should always be at hand. This is requisite in consequence of the great thickness and occasional hardness of the bone in cases where it has been chronically inflamed, by which one trephine may be rendered useless. Owing to a neglect of this precaution, Mr. Erichsen has witnessed a surgeon of eminence compelled to stop in the middle of an operation until a second instrument could be procured. After a circle of bone is taken away and the pus has escaped, the pyogenic or lining membrane must be removed by a Volkmann's spoon, the cavity thoroughly cleansed out with an antiseptic fluid such as chloride of zinc (gr. xl. to $\frac{3}{4}$ i.) and oiled lint, or iodoform gauze inserted.

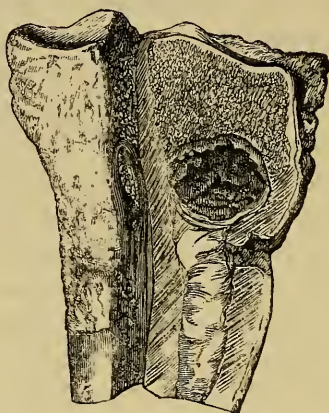
Mr. Savory² in a special case employed a method of operating slightly different from that usually practised. Instead of using the trephine immediately, he made a longitudinal incision in the bone with a small saw, and not until the pus oozed through the wound did he employ the trephine.

¹ *Lancet*, vol. ii., 1856, p. 34.

² *Lancet*, vol. i., 1874, p. 791.

The advantage claimed is that this method will give relief in case there should be only chronic inflammation, it gives a much wider range, and consequently an increased probability, of finding pus if any is present, and certainly the possibility of missing the abscess would be diminished by this mode of procedure. In case the trephine does not tap the abscess cavity (*fig. 13*) a chisel or perforator must be employed to explore the parts in the immediate vicinity, with the view of

FIG. 13.



✓ FIG. 13. — Unsuccessful trephining of a bone abscess (*Holmes*).

finding the pus. The following cases illustrate several of the points which have been alluded to above, and exemplify the results of treatment:—

ABSCESS (?) IN HEAD OF TIBIA; TREPHINING; CURE.

Case 10.—Ann M., aged nineteen, admitted into the Manchester Royal Infirmary, September 8th, 1884. Patient has never enjoyed very good health; has always been troubled with rheumatism in her limbs; had an attack of scarlet fever when fourteen years of age. Six months ago she fell on her knee, which became considerably swollen and stiff; she had various medicaments applied without obtaining any real benefit. When examined the right knee was found to be very much swollen, without there being any undue heat about the joint. No pain was felt when the part was gently handled, but when pressure was exerted there was a great deal of pain on each side of the patella. Some aching during the nights and when she attempts to move the limb. Patient was anæsthetised and a longitudinal incision

made over the inner side of the head of the tibia, and the periosteum divided and retracted; no apparent change in its structure. A trephine hole was now made in the tibia, and on removing the circle of bone a small quantity of dark-coloured fluid which was not puriform escaped. Some cancellous bone, deeply injected and very soft, was removed by a Volkmann's spoon, and a drainage tube inserted into the cavity. The aching subsided from this time, the cavity gradually contracted, the knee swelling subsided, and eventually she completely recovered.

ABSCESS IN LOWER END OF TIBIA; DISEASE IMPLICATING ANKLE JOINT;
RESECTION; CURE.

Case 11.—Elizabeth M., aged thirteen, admitted into the Manchester Royal Infirmary, February 25th, 1884. Has always enjoyed good health. One sister died of consumption; otherwise family history good. Seven years ago patient sustained an injury to the right foot, which is not the one diseased at present. The left ankle is much thicker than the right, the enlargement extending two to three inches above the joint. Swelling in front of the articulation, also behind on each side of the tendo Achillis, and below the malleoli, which are themselves much thickened. There is fluctuation behind the internal malleolus and in front of the external, in which situations there is an aching pain on pressure. Tarsus not involved in the disease. Sinuses have formed on the inner and outer aspects of the joint; no bare bone; no pain except when pressure is made on the heel. The diagnosis of ankle joint disorganisation consequent on disease in the lower extremity of the tibia was made. The ankle was resected, and in dividing the tibia the saw passed across a cavity with thick sclerosed walls and containing pus. A small patch of caries of the upper and posterior margin of the os calcis was scraped away with a spoon. The patient left the Infirmary convalescent after a sojourn of two months and a half. At the present time, August, 1887, the patient is able to walk well without artificial support.

ABSCESS IN EXTERNAL CONDYLE OF HUMERUS; OPERATION; CURE.

Case 12.—Thomas F., aged twenty-one, a fish dealer, admitted into the Manchester Royal Infirmary, October 6th, 1884. Has had several attacks of rheumatism the last three months ago. No history of injury or of syphilis. About eighteen months ago he felt a pain on the outer side of the right arm, very near the elbow. It was not severe, but decidedly worse during the cold weather. He had the painful part painted with iodine, without, however, deriving any benefit; of late the pain has been increasing. Patient is a healthy-looking man; a good deal of redness over and above the external condyle. The movements of the elbow joint are slightly interfered with, complete flexion and extension being impossible. A small painful swelling is to be detected close to the origin of the supinator longus. Operation under chloroform and under the spray. An incision two inches in length made in the axis of the limb over the swelling. After dividing the superficial structures and some muscular fibres, a few small splinters of bone came into view and were removed; at the same time a small quantity of pus escaped. A distinct cavity was exposed extending some depth into the substance of the bone, and lined by a membrane which was carefully removed. Wound plugged with iodoform gauze and dressed antiseptically. Cure within a month.

False Abscess of Bone, or Neuralgic Osteitis.—As already stated, pain in a bone does not always indicate the presence of an abscess. The researches of Kölliker and Kobelt have shown that nerve filaments exist in the proper tissue of bone; this, becoming inflamed, first produces a compression and then an inflammation of the nerves, causing pain of long duration. In all probability the neuralgia occasionally attending simple fractures can be explained in a similar way. When the pain disappears after months of suffering it is because the osseous canals of the new bone enlarge, the compression therefore ceasing. This explanation, however, will not hold good for all cases of neuralgic osteitis, inasmuch as this condition may be associated with rarefaction instead of condensation of bone. Neuritis by propagation probably accounts for the pain in these cases. In other cases it may arise from other causes, such as cavities not enclosing fluid, situated in the centre of a condensing osteitis.

Gosselin counsels trephining in neuralgic osteitis, and for several reasons: 1. Because the diagnosis is impossible between those cases where there is pus and where there is none. 2. Because there is no danger attending the operation. 3. Neuralgic osteitis may exist without any abscess cavity, but in these cases the bone is always hypertrophied by an old-standing osteitis. It is quite possible all the pain will not subside immediately the trephine is employed. This is more especially the case when the patient is hysterical, then some vague wandering pains, altogether different from those associated with bone abscess, may exist for a few days. These will however gradually disappear, and require no special treatment beyond attention to the general health.

Although abscesses are most frequently situated in the articular ends of the tibia, examples of the disease in the shaft of the bone are met with, as shown in the following case:—

ABSCESS IN SHAFT OF TIBIA; TREPHINING; RELIEF; INJURY; SUBSEQUENT AMPUTATION; RECOVERY.

Case 13.—John McN., aged twenty-seven, admitted into the Manchester Royal Infirmary, November 14th, 1881. Twenty years previously a swelling somewhat suddenly appeared immediately above the right ankle. It was painful, soon suppurated and discharged; subsequently several sinuses formed along the course of the tibia. Pieces of bone, which the patient described as narrow and about an inch in length, escaped from the openings. A period of six months elapsed between the onset of the swelling and the final closure of the sinuses. No injury had been sustained, and both before and after the appearance of the abscesses the patient enjoyed perfectly good health. His present illness commenced twelve months ago with occasional severe starting pains in the right tibia, that is in the same bone that had been the seat of disease many years before. The pains which were absent during the day would recur for two or three nights and then disappear for weeks. Three months from their first appearance they increased in severity and became more frequent; they now occurred both during the day and night. Six weeks before admission he noticed a gradually increasing swelling in the middle third of the right leg, in the situation where the pain had existed long. His condition on admission was as follows. There was a hard swelling occupying the middle third of the right tibia, it was confined to the front and inner side of the bone; it was prominent in the centre, and its upper and lower limits gradually shaded off into the contiguous parts; the skin over it was glazed and red; the parts were exquisitely tender, and extreme suffering was produced at one spot even by gentle pressure. Several cicatrices of former abscesses were still visible along the tibia, which was a quarter of an inch longer than its fellow. Some improvement followed the internal administration of iodide of potassium and the application of lead and spirit lotion. In a few days, however, the swelling markedly increased, as did also the pain. The superficial structures at the same time became œdematous; half an inch increase in the circumference of the limb was also recorded. As the symptoms pointed very strongly to an abscess within the shaft of the tibia and the patient's sufferings had become well-nigh intolerable, it was determined to employ the trephine to remove a circle of bone from the most prominent part of the swelling, where on pressure the pain was most acute. The periosteum, thickened and infiltrated, was divided in a crucial manner, and a circle of sclerosed bone half an inch in thickness removed; pus immediately welled up into the opening, and a considerable quantity escaped. A very distinct cavity, lined by a soft vascular pyogenic membrane, was displayed, but no sequestrum was detected. The lining membrane was scraped away by a Volkmann's spoon, the cavity syringed with a solution of chloride of zinc (forty grains to the ounce), and filled with antiseptic gauze; the patient experienced immediate relief; the anxious expression, denoting intense suffering, quickly subsided; sleep and appetite soon returned. In the course of a week granulations began to spring from the circumference of the cavity, and within two months the limb had assumed its normal shape and appearance. Unfortunately, the patient sustained an accident to his leg some months afterwards, which ultimately led to amputation. Examination of that part of the tibia where the abscess had previously existed showed granulations and fibrous tissue rapidly disintegrating, owing to the acute suppurative inflammation which

had been set up in the limb by the recent injury. The abscess cavity extended almost through the entire thickness of the tibia; a thin plate of bone at the posterior part alone remaining. A section of the tibia exhibited very decided and unmistakable traces of the old inflammatory mischief. In some parts the medullary canal was wholly and entirely obliterated. Immediately above the abscess cavity no trace of the canal could be discovered, the tibia forming a solid cylinder of dense osseous tissue. At the upper part the bone presented a tolerably healthy appearance. The chief point of interest in the case is the unusual locality of the disease, which may have been determined by the attack of inflammation during an earlier period of life. Is it not possible that the caseous remnants of an inflammatory process, which had long ago subsided, formed the starting point of a fresh morbid action? In this event, some examples of chronic bone abscess would correspond to residual abscesses in the soft parts.

CHAPTER VII.

CARIES.

Syn. ULCERATION OF BONE. RAREFYING OSTEITIS.

Caries of bone (*fig. 14* and *plate 6*) is one of the most difficult conditions to define accurately, and surgeons employ the term in widely different senses; some regarding it as a condition in which great friability and disintegration accompanies suppuration in a bone, others looking upon it as corresponding with ulceration in the soft parts.

FIG. 14. ✓



FIG. 14.—Morbus coxæ, resection. Rarefying osteitis on the diaphysial side of conjunctive cartilage (*O. C. Museum*).

German pathologists use the word caries as equivalent to rarefying osteitis. Billroth considers it synonymous with chronic osteitis, combined with disappearance of the bone, and mentions several varieties which depend upon the locality of the disease and the appearances of the morbid structures,—fungoid caries, atonic, torpid or caseous caries; he also mentions a necrotic form of caries.

Cornil and Ranvier consider that the various lesions described by different writers under the name caries are all the result of one initial lesion, which consists in a fatty change destructive of the cells contained in the lacunæ; they describe this as occurring in two periods: 1st. Bone cells undergo degeneration without there being previously the least sign of inflammation; 2nd. Osseous trabeculæ, destroyed by the death of their cellular elements, form so many foreign bodies, which determine suppurative inflammation around themselves. This second period alone is that described by other observers as caries.

Dr. Wilks regards caries as a disease of the bone which corresponds with scrofulous inflammation of the soft parts, and says that it shares all the obscurity of this class of diseases. He further defines scrofula as a slow caseous inflammation that arises without sufficient extrinsic cause, and does not show that tendency to recover which characterises inflammation from injuries in healthy subjects.

Caries may be regarded as a chronic osteitis, accompanied by rarefaction and disappearance of bone and generally associated with suppuration. It is closely allied to ulceration as seen in the soft structures, and ulcers in bone present varieties comparable with those in soft parts. Some show a marked tendency to heal, others increase both in depth and width, a third variety remain in an indolent state with little tendency to heal, while a fourth form become filled with granulations which tend to grow exuberantly; the last variety is often associated with the formation of tubercle.

Although difficult to define, caries presents certain clinical characteristics which render it comparatively easy of diagnosis. It frequently attacks the short bones of the tarsus and carpus and the spongy extremities of the long bones, being much less frequently encountered in their diaphyses. It also occurs in the spine, skull, and not unfrequently in the spongy structure of the sternum. Various forms of caries have been described,

PLATE, 6. V



viz., the simple, scrofulous or tubercular, and the syphilitic: a fourth variety, the phagedenic, is occasionally seen, its virulence largely depending upon a scrofulous or syphilitic taint. The tubercular and syphilitic forms of caries will be described when tubercle and syphilis in bone come to be considered.

Pathological Anatomy.—The disease being one of the results of osteitis, the changes at the onset are those already mentioned as characteristic of inflammation of the osseous tissue. The marrow becomes more vascular, its cellular elements proliferate, the partitions between the cancelli become thinner and often disappear, and so allow the junction of neighbouring spaces, which are filled with granulations formed from the proliferating embryonic medulla. Some of the granulations, especially when located in an epiphysis and communicating with an articulation, attain a considerable size and have been termed fungosities; tubercles are frequently found in these masses. The new granulation tissue filling the enlarged spaces undergoes destructive changes, and suppuration is in consequence induced. The cells of the granulation tissue become pus corpuscles, while the soft intercellular substance forms the liquid portion of the pus. If this change occurs rapidly, minute fragments of bone—found under the microscope to show true bony structure—will be detached and may pass out with the pus. This is the variety of the disease described as *caries necrotica*.

In that form of caries where no suppuration exists—described as *caries sicca*—the change in the granulation tissue falls short of its transformation into pus. The cancelli and spaces become filled with granulations which gradually replace the osseous tissue. These may disappear by absorption or partly remain and, undergoing osseous transformation, form new bone. This kind of disease is occasionally observed in the tarsus and carpus, and also not unfrequently in the spine; bodies of vertebræ may partially disappear without the production of any pus. The inflammatory character of the change

by which this is effected is made evident by the fact that a considerable amount of condensation has taken place in the osseous tissue surrounding the carious centre. When caries attacks the compact structure of long bones, the changes that ensue are almost identical with those encountered in cancellous tissue.

The progress of ulceration in bone will be largely influenced by the condition of the patient and the constitutional state in which the disease originates. It not unfrequently comes to pass that the amount of bone destruction is limited in extent, nature being equal to the task of circumscribing the disease and to the restoration of the part to a healthy state, generally with some condensation of the osseous tissue in the immediate locality of the caseous centre. Under other circumstances, such as a scrofulous diathesis, the extent of bone disintegration is widespread; and severer forms, where the disease tends to assume the phagedenic character, will be encountered in debilitated patients whose constitution is seriously undermined.

Symptoms.—As caries is generally preceded by chronic inflammation in the osseous tissue, the symptoms first observed are those associated with this condition, and as they have been already referred to at some length they need not be repeated here. After the symptoms of chronic osteitis have been in existence for some time, an abscess will as a general rule form, and when this is opened or gives way spontaneously the character of the disease will be at once apparent on the introduction of a probe. The diseased bone readily breaks down, not unfrequently bleeds, and the examination is attended with some pain. There are other circumstances, in addition to the locality of the disease and the attendant symptoms, which lend substantial aid in discriminating caries from necrosis.

It is important to observe the quality of the discharge from the sinus communicating with the diseased focus. It is usually unhealthy, often sanious, sometimes foetid; and contains excess of lime salts, also frequently minute bony granules or small

sequestra. The fistulous tracks into which the abscesses contract are often very tortuous, and considerable care is requisite in conducting the exploration with the probe, otherwise the bone disease in which the abscess originates may be very easily overlooked. Professor Sayre has invented an ingenious instrument (vertebrated probe), which follows the curves of an irregular canal and aids in discovering carious bone. An example of the tortuosity of a sinus is afforded by caries of the head of the femur, the opening leading into a long sinuous channel being constantly below and slightly posterior to the trochanter major.

The course of the suppuration is to a certain extent determined by gravity, and is largely due to ulcerative inflammation. The character of the pus and the tortuous nature of the sinus, along which it has to travel, contribute to produce septic inflammation in the tissues situated near the ulcerating bone; this will seriously aggravate the disease, and the greatly increased suppuration will help to impair the health still further, and may very possibly induce septic poisoning. A cachectic condition is often seen in caries of the tarsus, where abscesses have been permitted to give way of their own accord, and the pus to become putrid. The initial mischief may have been very circumscribed, but the superadded injury induced by the unhealthy pus may be so extensive as to immensely increase the difficulties of preserving the limb.

Terminations.—In simple, circumscribed caries, that associated with a fairly healthy constitution the ulcerative process often ceases, and the granulations assuming a firmer and more healthy appearance, become gradually transformed into a dense organised tissue. The formation of pus is suspended and the inflammatory symptoms disappear. New osseous material is produced in the fibroid tissue, and the deficiency in the bone is in this way made good, or, the cicatrix continues as a permanent and adherent depression. In those examples of osseous ankylosis following complete destruction of a joint,

the granulations springing from contiguous articular surfaces become blended and ossify. When caries is connected with a constitutional dyscrasia, the prognosis will necessarily depend on its nature. The syphilitic form yields to specific remedies, while that variety associated with the production of tubercle often proves very rebellious and unsatisfactory.

Treatment.—When caries arises from a constitutional disease, such as scrofula or syphilis, and is merely the local expression of a general condition, it is of the greatest importance to exhibit remedies to counteract the dyscrasia. When associated with scrofula, improvement of the general health by tonics, especially cod liver oil and the syrup of the iodide of iron, together with, if possible, change of air and prolonged residence at the seaside, will be found to be of the greatest service. Syphilis is best treated with iodide of potassium. These remedies will often succeed in effecting a cure without any special local treatment, this being so, we should avoid having recourse to any operation until the general treatment has had a fair trial.

The local treatment varies with the stage at which the disease has arrived. At the commencement, if the inflammatory symptoms run an acute course, means must be adopted to subdue them. The local abstraction of blood by means of leeches may moderate the pain and tenderness. It must not be forgotten, however, that depletory measures are rarely justifiable, for the disease often appears in debilitated subjects, and if it does not subside at an early stage the patient will need all the strength that he possesses. Warm fomentations often give relief, so also does the application of a counter-irritant, such as iodine. But it is open to great doubt whether these remedies exercise any modifying influence on the osseous inflammation. The beneficial action of issues and setons is still more disputed. Brodie condemns them when he says: "I much doubt whether setons and issues are ever useful, except in some cases in which the disease has its seat in the hip joint." Barwell regards them as useful in the earlier or inflammatory

stage of caries, but denies them all value in the destructive stage of the disease. It is possible that the value of these remedies will depend on the nature of the caries, which is equivalent to saying with the constitution of the patient (Markoe).¹

When the pain is severe and persistent, the best treatment and the one which affords immediate relief is to expose the bone, and open up its cancellous interior with a trephine. If this were done more often in cases of chronic osteitis of articular extremities, we should witness the destructive effects of caries in joints much less frequently. The abscesses, which form in the soft structures covering an ulcerating bone, are to be opened early and freely, and the incisions to be so planned as to afford a ready exit for the pus. Any lodgment or burrowing of matter is to be dealt with promptly. The discharge is to be kept free from septic changes by the use of disinfectants, and the abscess cavity is to be syringed out with a solution of corrosive sublimate (1 in 2,000) or tincture of iodine (1 part to 3 or 4 of water). By the persistent use of these measures and careful attention to the state of the health, the bone ulcer may prove manageable, and heal without much difficulty.

We should not neglect to insist on the necessity for rest in the early stages of caries. This is urgently required when the disease is situated in immediate proximity to a joint which only too readily becomes implicated in the morbid action. The need and value of absolute and persistent rest in carious disease of joint ends of bones is conceded by all authorities. There is, however, great diversity of opinion in regard to the length of time the rest should be observed, and what the indications for moving a joint that has been fixed are. This question, a very wide and important one, belongs more properly to the subject of joint diseases.

Should the means advised prove insufficient and the disease show no signs of subsiding, an operation for the destruction

¹ *Loc. cit.*

or removal of the disintegrated osseous tissue becomes indispensable. The older surgeons employed the actual cautery, and often with the happiest results. Pollock and others make use of caustics (sulphuric acid, Pollock; hydrochloric acid, Chassaignac; Vienna paste, Fitzpatrick) for the same purpose. The bone is exposed and the acid diluted with an equal part of water at first, afterwards nearly pure, is applied by means of a dossil of cotton wool or a glass rod. After the crumbling bone has been got rid of, granulations will form and a healthy action is produced, this may, however, require several applications of the acid. The Vienna paste is applied after the osseous tissue has been freely laid open.

Most often a gouge or a Volkmann's spoon is the instrument employed for removing soft, disintegrating bone. It will be found advantageous to render the limb ischæmic by the application of Esmarch's bandage before commencing the operation, the boundaries of the diseased area being thereby rendered easier of definition. The constant oozing of blood when the limb has not been made bloodless seriously thwarts the surgeon, and often prevents him from determining the true limits of the disease. Other instruments are employed in the removal of carious bone, and have proved very useful, such as Marshall's osteotrite and the gouge forceps recommended by Erichsen. When the operation is completed, and the whole of the fragile, crumbly, grayish bone, together with the granulations lining the sinuses, have been removed, the parts are thoroughly purified with a sublimate solution or chloride of zinc (40 gr. to $\frac{3}{4}$ i.) and plugged with iodoform gauze, the whole being covered with antiseptic wood-wool pads.

When the disease is near an articulation, or involves the carpus or tarsus, the limb after operation should be fixed either on a splint or if possible in a plaster of Paris apparatus, spaces being left for the renewal of the dressings. The size of the cavity, the amount of secretion from it, and the sensations of the patient will generally decide the number of days the dress-

ings should remain in place before they are renewed. With each renewal the cavity is to be syringed out with some anti-septic solution and iodoform blown into it from an insufflator.

A very considerable number of the operations for the removal of carious bone take place in the foot and hand; the choice of operation will depend, of course, on the situation and extent of the disease, and also on the age of the individual. Whenever possible we adopt rules for our guidance in operations for the removal of disease, similar to those we observe in accidents. The least sacrifice of parts compatible with the requirements of the case must be our guiding principle at all times, provided always that the whole of the diseased structure is removed. With this object it is very important to localise disease in the tarsus, and to bear in mind the direction in which it is likely to spread; a knowledge of the synovial membranes of the foot is very useful here.

It is often very difficult to determine the extent of the caries; the situation and number of the sinuses do not constitute reliable evidence on this point, and the condensation of the surrounding soft parts often reaches a considerable distance beyond the disease in the bone. The surgeon may be quite sure that he has overtaken the disease when the bone exhibits a pink, vascular appearance and presents a certain resistance, very different from the dark or dirty white colour and the soft, friable texture of carious bone.

In case the disease implicates the articular extremities of the bones, the question of resection *versus* amputation has to be decided. In some joints the propriety of removing articular ends that are diseased can no longer be a matter of doubt. The operation furnishes excellent results in the elbow joint. We can promise the patient that the disease will be completely removed, and with every prospect of a very efficient limb resulting. The same, however, cannot be said of any other joint. The indications for operation will vary with the different joints, and no rules of universal application can

be submitted. The last word has not been said about resection of joints like the knee and hip. In the former the formal operation is not usually performed before the age of six years; prior to this the plan of carefully and thoroughly removing diseased structures, without formally taking away the joint ends, seems to be rather generally adopted on the continent and by some surgeons in this country.¹ For the hip we have advocates of early excision, while others consider the procedure not justifiable until the disease is attended with suppuration. Those who have devoted much thought and attention to the subject are convinced that success largely depends on the operation being performed early, before the health has become seriously impaired by the progress of the disease. Resection of the knee yields excellent results when performed about puberty. I consider from fifteen to thirty the most favourable time for excising this joint. When performed between six and fifteen, although at the time the result may be satisfactory, the growth of the limb is often much interfered with, and very frequently it becomes deformed and comparatively useless, so that after some years the patient may elect to part with a limb whose utility is very doubtful, and which, in some instances, renders progression difficult and leads to positive deformity, such as curvature of the spine. When circumstances do not favour resection, amputation will become necessary, and this proceeding will be also requisite when resection, from whatever cause, has proved unavailing. In case caries is limited to a single bone, such as the os calcis, it is quite possible to remove it completely, leaving the other bones of the tarsus. This has often been done with the best results, and the practice has been extended very much of late, as the cases² already published will testify.

¹ See *Medical Chronicle*, 1885, vol. ii., p. 271, for cases of Erasion of knee joint, by my colleague, Mr. Wright.

² Dr. H. Macnaughton Jones, *Lancet*, 1879, vol. i., also 1881, vol. ii., p. 1. Conner, *Amer. Journal Med. Sciences*, October, 1883. Wright, *Medical Chronicle*, 1886, vol. iv., p. 461.

CHAPTER VIII.

NECROSIS.

Necrosis signifies death of bone, and is the result either of injury or of osteitis. Caries, as already stated, corresponds to ulceration in the soft parts; so necrosis may be looked upon as being equivalent to gangrene; the distinction being that in one there is molecular death, while in the other a considerable portion perishes. The cause directly responsible for necrosis is the arrest of circulation from occlusion of the blood-vessels of the Haversian canals by inflammatory products, either pus or new osseous tissue. The main clinical distinctions between necrosis and caries have been mentioned in the preceding chapter. Necrosis, although usually situated in the compact bone, is not exclusively confined to this structure, for we find sequestra in carious cavities occurring in cancellous bone, as, for example, in the os calcis, the head of the tibia (*fig. 15*),

FIG. 15. ✓

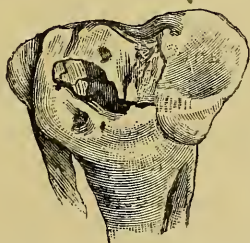


FIG. 15. — Sequestrum in upper epiphysis of tibia, cavity communicating with knee joint (*O. C. Museum*).

and in other situations. It, however, occurs much more often in the shafts of long bones, the commonest sites being the

anterior surface of the tibia (*fig. 16*), lower end of the femur, and the humerus. It is also met with in the clavicle, ulna, radius, lower jaw, and the cranial bones: necrosis in the latter

✓ FIG. 16.



FIG. 16.—Necrosis of the greater part of the anterior surface of the tibial diaphysis, following acute osteomyelitis (*O. C. Museum*).

bones being often associated with manifest constitutional state induced by syphilis. An acute form of necrosis is seen in the last phalanx of the thumb or of the fingers, resulting from inflammation commencing either in the periosteum or the neighbouring tissues. Necrosis, being the consequence of a certain morbid action, cannot be regarded as a disease *sui generis*, the death of the bone being the result of the sudden arrest of the flow of blood.

Causes.—Injuries bring about mortification of a bone by inducing certain pathological changes within its substance: or they may also occasion it directly by destroying the elements of which the osseous tissue is composed. Injury to the periosteum with exposure of the bone need not necessarily be followed by necrosis. The tibia is sometimes deprived of periosteum by its being stripped off, and recovery ensues without any exfoliation of bone. This fortunate result occurs most often in young subjects, when the circulation in the bone itself has not sustained any serious disturbance, for this would in all probability lead to inflammation, which in conjunction with the loss of periosteum would almost inevitably produce death of the bone. In case no necrosis follows destruction of the periosteum, the granulations originating on the surface of the bone will produce a new fibrous covering. As regards removal of periosteum,

Ollier says that under favourable circumstances necrosis will not follow, but a reproduction of true periosteum will take

place, and that in animals even the simultaneous removal of both periosteum and marrow does not always give rise to necrosis.

When necrosis follows inflammation commencing either in the periosteum or the medulla, inflammation of the osseous tissue proper is usually present as a secondary lesion, so that we may regard osteitis as exercising a very prominent and indispensable part in bringing about the death of a bone. Again, whenever osteomyelitis or periostitis is followed by necrosis, the latter is mainly the result of a secondary osteitis, which stops the circulation of blood in the diseased portion of the bone, by exercising pressure on the blood-vessels contained within the firm resisting walls of the Haversian canals. The osteitis that produces necrosis is often acute, and follows acute osteomyelitis or acute periosteal abscess; diseases frequently seen during the period of active growth.

Necrosis is also associated with the osteitis (osteomyelitis) attacking the cancellous articular ends of long bones, and with the same disease in the smaller spongy bones. In these situations, too, it often accompanies tubercular disease and the more chronic forms of inflammation. Certain fevers, such as scarlatina and typhoid, are not unfrequently followed by necrosis. This arises either from a deteriorated state of the blood, or from the feeble circulation permitting congestion in the vessels of the bone. The relations between typhoid, rheumatism, and the acute bone inflammations resulting in necrosis have been already fully discussed.

Necrosis in stumps is generally the result of chronic or subacute suppurative osteomyelitis. The marrow is chiefly implicated, and the disease extends to the proper osseous tissue; but the periosteum does not readily share in the suppurative inflammation; in it the irritation excites the formation of new bone. Annular necrosis, arising from injury during the application of a saw, is usually seen in the dense, hard, compact tissue of the shafts of long bones. Necrosis may be

confined to the exterior of a bone—*peripheral necrosis* (plate 7), or to the inner surface of the compact substance or the cancellous structure—*central necrosis* (fig. 17), or the entire substance of a bone, or the whole thickness of a shaft may be involved—*total necrosis* (fig. 18).

FIG. 17.

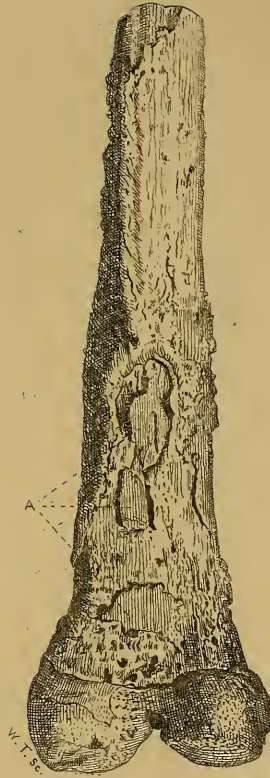


FIG. 17.—Central sequestrum, section of fig. 19 (O. C. Museum).

Dead bone, in a state ready for elimination, is named a sequestrum, and nature, as a rule, at once proceeds to cast it off. Being a foreign body, it excites inflammation of the bone in its immediate vicinity, and very soon it becomes surrounded with granulations. The change in the living bone, at its junction with the dead portion and by which the latter becomes separated, is a rarefactive osteitis. The medulla in the Haversian canals proliferates, the osseous walls become more and more attenuated, and at last completely disappear, leaving the sequestrum isolated. The line of demarcation is produced by ulceration in the osseous tissue, immediately surrounding the dead portion, and total separation between the two only takes place when all vascular connection between them has been completely destroyed. The line of demarcation is always formed at the expense of the living bone. In consequence of this, the sequestrum is smaller than the cavity in which it lies by the amount of healthy osseous tissue destroyed in the process of separation.

A distinction is often drawn between a sequestrum and an exfoliation; the former being surrounded by a covering of new bone designated an involucrum, which is absent in an exfoliation. In the involucrum are found one or more openings, called cloacæ (fig. 19), which give exit to the pus, and through which the sequestrum can be readily discovered by the aid of a

PLATE. 7.





probe. An invaginated sequestrum, that is one surrounded by a casing of new bone, is never in direct contact with the bone which surrounds it, being separated from it by a layer of granulations, which constantly secrete pus. When the pus is not easily drained away and remains, the fluid portion disappears, the remainder undergoing caseous degeneration.

The appearances of a sequestrum largely depends on the character of the lesion which precedes the necrosis. Usually it presents a dry, whitish or yellowish white colour, changing

FIG. 18. ✓

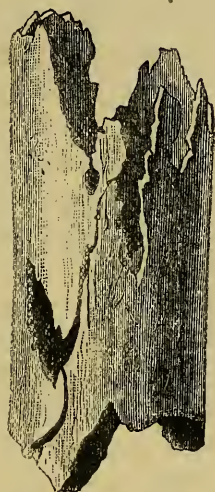


FIG. 18.—Total necrosis occurring in the femur after amputation
(O. C. Museum).

by exposure to dark grey, brown, or black. It is not sensitive, possesses scarcely any odour, and yields a clear, hard sound when struck with a probe. Its free surface is smooth, occasionally porous, and its margins are irregularly spiculated (*fig. 20*), while on the opposite side it generally exhibits numerous furrows and depressions, which correspond with the unevenness of the granulating surface. The irregularity of the margins should be borne in mind when the operation of removing a sequestrum is undertaken, so as to avoid fracturing

any of the small spicules, which, if left in the cavity, will require removal at some subsequent period before a cure can be effected. It is far better to lay the involucrum freely open than to allow any of the dead bone to remain as a troublesome

FIG. 19.



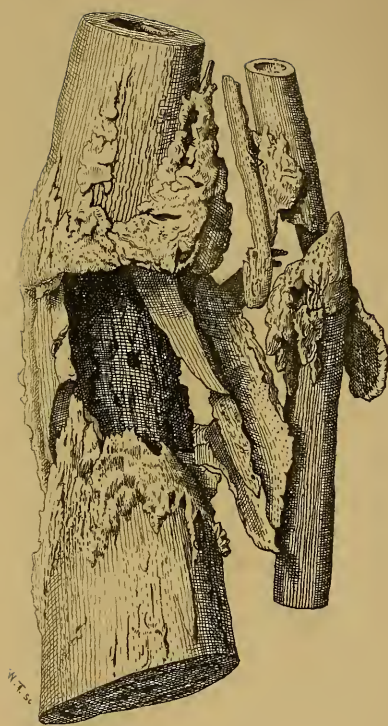
FIG. 19.—Cloacæ leading to a central sequestrum in tibia (*O. C. Museum*).

source of irritation. The sequestrum, which follows mephitic or moist gangrene of osseous tissue, shows certain special characters. In colour it varies from grey to greenish brown, and exhales the peculiar unmistakable odour of decomposing bone. In necrosis proceeding from the inhalation of phosphorus fumes, the sequestra are heavy, eburnated, and often possess superficial spongy osteophytes derived from the periosteum.

When an entire bone or a large portion of a diaphysis of a long bone dies, the subperiosteal medulla proliferates, becomes embryonic, and produces new osseous tissue under the periosteum (*plate 8*). The amount of new bone varies, sometimes it forms a thick covering, which may interfere with the extraction of the sequestrum. The spontaneous expulsion of a sequestrum is effected in a large measure by the growing granulations lining the involucrum. During its extrusion the safety of important structures is seriously endangered, and cases are on record where the popliteal artery has been perforated by a sharp irregular sequestrum from the lower end of the femur. A sequestrum may be invaginated for a long period. Broca mentions a case where it had continued so for fifty-three years. What becomes of the cavity after the

expulsion or removal of a sequestrum? The secretion of pus speedily diminishes and ultimately stops, while the granulation tissue becomes converted into bone. The activity of the peri-

PLATE, 8. ✓



osteum declines, the surface of the bone loses its irregularities, and in course of time the medullary canal is probably to a considerable degree re-established.

Symptoms.—As a large number of the cases of necrosis arise from acute bone affections, the symptoms in the early stages are those associated with periostitis, osteitis, or osteomyelitis, diseases which, causing obstruction in the blood supply of a bone, frequently cause its death. When this has occurred, the symptoms are those that accompany the separation of the dead portion and its detention as a foreign body. Owing to the irritation due to the presence of the sequestrum, abscesses will appear, discharging spontaneously unless opened, and instead of healing passing into fistulous channels, at the

FIG. 20. ✓



FIG. 20.—Sequestrum of tibia. Acute osteomyelitis sixteen months before (O. C. Museum).

bottom of which the dead bone can be detected by a probe, and through which the sequestrum may protrude (*fig. 21*). Beneath the periosteum new osseous tissue, destined to replace the dead portion, is produced; this forms a sheath which is called the involucrum, and surrounds the dead bone, in it usually there are several openings termed cloacæ, and the introduction of probes through two of these openings will afford some evidence of the separation and mobility of a sequestrum if pressure made on one is transmitted to the other and elevates it. Sometimes small fragments of dead bone will be expelled; others may disappear, and it is difficult to explain how this is brought about, the solvent action of the pus being very limited, if it exists at all (Cornil and Ranvier). It is most probably due to the action of the cellulo-vascular buds of the inflamed medulla.

When necrosis is associated with other diseases of bone, such as caries, the symptoms possess certain peculiarities which may be easily deduced from the histories of the several affections. In cases where the necrosis is central and where the continuity of the bone is maintained, the symptoms

FIG. 21. ✓



FIG. 21.—Sequestrum, resulting from osteomyelitis, projecting through sinus on the leg (*Lannelongue*).

resemble very closely those caused by chronic abscess of bone. Generally there is deep-seated pain, pus is formed in the cancellous tissue immediately surrounding the necrosed portion, and after the lapse of some time a fistulous passage is estab-

lished by ulceration through the bony walls, and through this opening the pus, and at times sequestra escape from the interior (*fig. 22*).

Treatment.—The treatment at the onset will obviously depend upon the nature of the disease which induces the necrosis. When the lesion is acute, decisive measures must be employed to allay the inflammation. Warm applications locally, combined with the use of opium internally, may relieve the patient's suffering, and early and free incisions may very possibly check, or at any rate limit the necrosis which is about to take place. When the necrosis is associated with certain diathetic states, such as struma or syphilis, the treatment will have to be modified accordingly. It seems

FIG. 22.

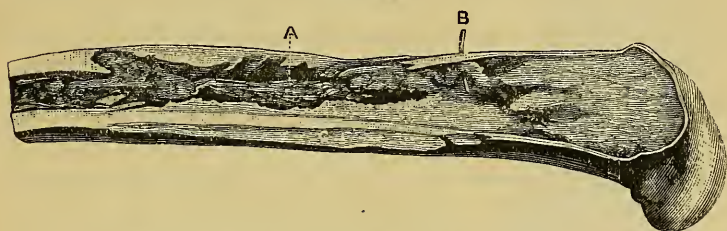


FIG. 22.—Central necrosis following acute spontaneous suppurating osteomyelitis. M., æt. 31.

A. Sequestrum lying loose in the interior of the femur.

B. Opening made by nature for the purpose of getting rid of inflammatory products.

C. Subperiosteal, new formation of bone.

The case is published in the *Medical Chronicle*, 1884, vol. i., pp. 126-7.

scarcely necessary to say that when necrosis arises from the inhalation of deleterious fumes, as for example of phosphorus, means must be adopted for withdrawing the patient from their operation.

Strictly speaking the only treatment for necrosis, which should be considered here at any length, is that which appertains to the removal of the bone when dead and completely separated. Until this has taken place, the surgeon can do but little except employ the treatment applicable to the disease

which has ended in the death of the bone. The process of detachment of the dead bone is generally slow, usually several weeks or months passing away before it is completed; it is more rapid in young subjects, and also when the necrosis happens in spongy bone tissue. While it is proceeding abscesses frequently form in the soft structures overlying the diseased bone; these should be opened in the most dependent positions. The general health will be benefited by tonics, such as iron, cod liver oil, and bark preparations, together with the careful administration of nourishing food. Under certain conditions, which have been already discussed, the removal of a sequestrum may be carried out before it is entirely separated; for the indications of this method of treatment see subperiosteal resection.

Sequestrotomy, or the removal of a sequestrum, as the dead, separated bone is called, should be undertaken as soon as the detachment is complete. Before commencing the operation (when on the limbs) a tourniquet is applied after temporary elevation of the limb to empty it as far as possible of blood, or the extremity may be rendered ischæmic by applying Esmarch's apparatus. Any sinuses that may exist in the soft parts are to be enlarged, or a new incision may have to be made; due precautions being observed in order to avoid structures of importance. The bone is to be denuded sufficiently to give the operator ample room for the manipulations requisite to remove the sequestrum. In peripheral necrosis no difficulty is likely to be encountered, the exfoliated bone being easily displaced. When, however, the sequestrum is enclosed in an involucrum, or is central and situated some distance from the external sinus (*fig. 23*), its removal may be troublesome, and often difficult, requiring both time and care, and in certain localities the operation will be attended with a not inconsiderable amount of danger owing to the proximity of important structures.

The aperture or apertures (cloacæ) in the involucrum

must be freely enlarged; a chisel and mallet or a cutting forceps being employed for the purpose. When the disease is of moderately recent date, the involucral wall will be vascular, soft and porous, and easily divided; when old the involucrum will be harder and occasionally it is very dense, thus rendering the operation tedious, besides increasing the risks. Very often the cloacæ are so situated that by removing the interjacent portions of bone an opening of suitable size will be produced. The sequestrum is now to be seized with a forceps and removed; when large its extraction will be facilitated by dividing it. There should be no unnecessary dread of freely cutting the involucrum, a successful result being more certainly and easily obtained by making the opening in it sufficiently free to permit the complete extraction of the sequestrum.

It is most undesirable to exercise much force, as some of the fine spicules of the sequestrum are very easily detached. In this way some dead bone will be left in the cavity, and the operation will be unsuccessful; as a cure cannot be effected until all the sequestra have been got rid of. Another argument in favour of observing great caution in extracting a sequestrum,

more especially one which has separated from the lower end of the femur, is found in the fact that an irregular, jagged piece of dead bone in close proximity to a large vessel may readily penetrate its coats, and cause a condition which may necessitate removal of the limb.

FIG. 23. ✓



FIG. 23.—A central sequestrum in the lower end of the femur, protruding through a cloaca. Osteomyelitis thirteen years before (*O. C. Museum*).

A case reported by Mr. Butcher¹ shows how serious difficulties may be successfully combated. It was one of extensive disease of the lower end of the thigh bone, with a large projecting piece threatening the popliteal vessels; the sequestrum was removed by a somewhat severe operation, and perfect recovery ensued, with entire use of the limb. H. R. G., first seen by Mr. Butcher in November, 1880, was much emaciated and enfeebled, there was history of an injury to the right knee joint. Abscesses formed about the joint and discharged for nearly three years. On introducing a probe into the external sinus it passed into the popliteal space, and in its course detected diseased bone; on passing the probe through the opening on the inside of the joint the same condition was revealed. In this examination a long, sharp piece of the femur, extending towards the popliteal space, was detected. The following operation was performed with success. An incision, fully five or six inches long on the outer side of the lower end of the femur, was made, down to the bone; the handle of the knife was used to detach the vessels and the soft parts. The diseased bone was cleared away by means of the gouge, the chisel, and mallet, the sharp projecting piece being chipped away with a cutting gouge. This was very difficult, owing to the near proximity of the large vessels to the diseased bone.

Amputation may be required whenever free hæmorrhage occurs from penetration of a large vessel, or from the granulations lining the cavity which contains the sequestrum. Penetration of the knee joint by an irregular sequestrum connected with the lower and back part of the femur will also as a general rule demand removal of the limb.

After the sequestrum is taken away a cavity, lined with vascular granulations, is exposed (*fig. 24*). These had better be removed with a Volkmann's spoon, the parts thoroughly purified with a chloride of zinc solution (gr. xl. to $\frac{3}{4}$ j), and the

¹ *Dublin Journal of Medical Science*, 1881, vol. lxxii., p. 396.

cavity *lightly* stuffed with iodoform gauze. Should the hæmorrhage be free, as it sometimes is after the elastic band has been removed, a warm antiseptic solution (carbolic solution at 105° F.) will be found of service in checking it. Hartmann's medicated wood-wool is a convenient dressing, and over it a bandage is to be applied, firmly whenever oozing of blood is feared; elevation of the limb may also be of service in effecting the same purpose. Lint soaked in carbolic oil (one in ten) or in terebene is often substituted for the iodoform gauze to fill the space left after removal of the sequestrum.

Under ordinary circumstances, the amount of pus secreted will soon commence to decrease, and healthy granulations springing from the walls of the cavity quickly fill the space. These will ultimately ossify, and the bone be converted into a mass of compact tissue. Much of this is eventually removed, nature frequently attempting with some measure of success to restore the continuity of the central canal.

Occasionally the discharge from the cavity, instead of decreasing, has a tendency to increase, the granulations assume an unhealthy, indolent appearance, and things may remain in this condition for some very considerable time, even when the dead bone has been entirely and completely removed. Healing is consequently delayed indefinitely; before it takes place the diseased granulations must be carefully scraped away, and the cavity freely washed with an antiseptic solution. By careful attention to

FIG. 24. ✓



FIG. 24.—Acute osteomyelitis of the tibia, cavity left after removal of the sequestrum (O. C. Museum).

the after treatment, and the observance of rest, all will usually now go on well.

When the granulations have reappeared, and are nearing the superficial limits of the bone cavity, and when the quantity of pus secreted is moderate and diminishing, the process of healing can be very decidedly hastened by placing small pieces of periosteum on the surface of the bed of granulations. The periosteum employed for this purpose should be taken from a situation where it is still in activity. The following case is one in which the periosteum from the tibia of a young patient, obtained from an amputated limb, was placed on granulations springing from the walls of an osseous cavity in the lower part of the leg, after removal of a sequestrum following acute suppurative osteomyelitis of the tibia:—

OSTEO-PERIOSTITIS OF TIBIA; CAVITY REMAINING IN THE BONE AFTER REMOVAL OF SEQUESTRUM; PERIOSTEUM GRAFTED; RECOVERY.

Case 14.—M. B., aged twenty years, admitted into the Manchester Royal Infirmary, March 22nd, 1886. He attributes the condition of his leg to a sprain of the ankle received four years ago; he suffered severe pain in his right tibia, the leg becoming swollen. He does not know whether the pain or swelling came first. Sinuses formed along the anterior surface of the bone a few weeks after the onset of the pain, and several pieces of dead bone came away, one piece being four inches in length. The diaphysis of the right tibia is much enlarged, being nearly twice the size of the left; the skin over it is dusky red, and adherent to the bone. Small depressions indicate the position of former sinuses which have healed up. About three inches above the internal malleolus, and lying rather obliquely to the long axis of the tibia, is a cavity (*fig. 25*) three inches in length, an inch in width,

FIG. 25.

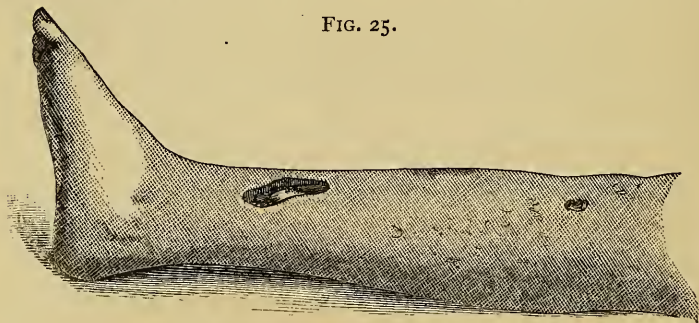


FIG. 25.—Cavity in the lower end of the tibia, formerly containing a sequestrum. At the upper part is the cicatrix of a former sinus.

and the same in depth, filled with pulpy granulations, and discharging thin pus. This cavity was freely scraped out with a Volkmann's spoon and some pieces of dead bone removed, the parts thoroughly syringed out with chloride of zinc (40 grs. to the ounce), and stuffed with iodoform gauze. Healthy granulations formed in the cavity, and when the discharge was diminishing, some small pieces of periosteum half an inch long and one-eighth of an inch broad, taken from the tibia of an amputated limb, were inserted. This afforded the necessary stimulus, the cavity filling up very quickly and healing over in a little more than three weeks.

Sometimes, after the removal of a sequestrum, a large cavity is left in the lower end of the femur which seems to be incapable of healing, and is often a source of prolonged suppuration. Dr. Lange,¹ following Neuber, has successfully operated upon such cases by reflecting a flap from the soft parts covering the lower part of the thigh, then removing the whole anterior wall of the bone cavity, which is scraped and disinfected; the flap, whose length should correspond to the extent of the cavity, is now depressed, and fastened in position by means of a nail or a needle. No sutures are introduced. It is remarkable how the flap is elevated and the depression disappears in the course of some months.

Whenever necrosis implicates the whole of a bone of the hand or foot, it may be removed in its entirety, the periosteum alone being left. This practice is often adopted with some measure of success in disease of the metacarpal and metatarsal bones, also in the phalanges. The result is, however, at times disappointing, owing to the small amount of bone reproduced; the bone-producing function of the periosteum seeming in these cases to be crippled by the inflammatory process which induces the necrosis; this is especially the case when it is acute. Total subperiosteal resection has also been practised on the bones of the forearm, fibula, tibia, and lower jaw.

When necrosis of the tibia is extensive, we must provide the limb with some artificial support after removal of the sequestrum, and for some time subsequently. A neglect of this pre-

¹ *Medical News*, vol. i., 1884. Paper read before New York Surgical Society, Feb., 1884.

caution may lead to yielding of the casing of new bone, with considerable amount of deformity of the limb, as the following case shows:—

OSTEOMYELITIS OF TIBIA; NECROSIS AND REMOVAL OF SEQUESTRUM;
SUBSEQUENT DEFORMITY OF NEW SHAFT; OSTEOTOMY.

Case 15.—William R., aged eighteen, admitted into the Manchester Royal Infirmary, April, 1886. He is a strong, healthy-looking lad, and, apart from the disease in his leg, has enjoyed very good health. Six years ago he suffered from acute suppurative osteomyelitis, with apparently typical symptoms. He was an inmate of a hospital in the south, and underwent the operation of sequestrotomy. It does not appear that he afterwards wore a splint or any other support. Two years ago he noticed his leg beginning to curve outwards, and the deformity has gradually increased. The outward curve in the tibia commences very abruptly, just below the tubercle, at a point corresponding with a large cicatrix, the position of a former sinus. The tibia is thickened at its upper part, the head of the fibula is very prominent and apparently displaced outwards, the whole limb being much bowed, with the concavity looking forwards and inwards. The limb having been rendered ischæmic, and while the patient was under the influence of chloroform, a tenotomy knife was introduced on the inner side of the tibia three inches below the tubercle and in the situation where the curve was most evident. The bone, which was sclerosed and thickened, was divided almost through with an Adams' saw, and then broken. The straightened limb was placed on a back splint and side splints applied. The cicatrix over the portion of bone sawn through ulcerated and delayed the healing; otherwise the patient made an excellent recovery, and on his discharge, with the exception of a slight falling backwards at the upper part, the limb was perfectly straight.

Necrosis in the flat bones differs from that in the cylindrical bones in that the sequestrum is not enveloped by a sheath of new bone. The process by which the sequestrum is disconnected is in every way analogous to that already mentioned. In some situations, however, the progress of the separation is exceedingly slow, the denuded bone remaining fixed and immovable for several months and may be years. Such persistence is often witnessed in the pelvic bones, when the morbid action is dependent on a tubercular condition, and is accompanied not unfrequently by disease of the spine. Those who are labouring under necrosis of these bones often suffer from other morbid lesions, more especially amyloid degeneration of internal organs, induced by prolonged suppuration or tubercular affection of the lungs. These diseases or exhaustion

will often be the immediate cause of the fatal termination. An exception to the rule laid down above is observed in necrosis of the iliac crest, where the detaching process advances more rapidly, and the separation is completed within a reasonable period.

Necrosis of Epiphyses and of Articular Extremities of Bones.—When necrosis attacks the shaft of a long bone it is often limited to it; when situated in the epiphysis or the articular end of a bone, the integrity of the neighbouring joint is seriously threatened. It is incumbent upon us, therefore, to watch an osseous inflammation in the near vicinity of a joint with due vigilance, and if possible to prevent necrosis by perforating the bone early. Reference has already been made to this affection when treating of osteomyelitis of epiphyses. Strictly speaking, the necrosis is only the consequence of a pre-existing inflammation, usually of a subacute character.

Attention has been called to the disease in connection with the acute arthritis of infants, first described by Mr. T. Smith.¹ In many of his cases the disease was accompanied by symptoms of septicæmia, and followed by death, and in many cases more than one joint was affected in the same patient.

Mr. W. Marrant Baker directed¹ attention anew to this subject in a paper read in the section of Diseases of Children at the Liverpool meeting of the British Medical Association in 1883.² All his cases, with one doubtful exception, ended in recovery with preservation of the limb. It is uncertain, therefore, whether any necrosis occurred; but the symptoms in those where necrosis was demonstrated bore such a close analogy to those in which recovery takes place, that the presence of necrosis may be fairly inferred in the latter.

Mr. Eve³ calls attention to the same matter in a paper "On necrosis at the extremity of the diaphyses and in the epiphyses

¹ *St. Bartholomew's Hospital Reports*, vol. x., 1874, p. 194.

² Epiphysial necrosis and its consequences, *British Medical Journal*, vol. ii., 1883, p. 416-419.

³ *St. Bartholomew's Hospital Reports*, vol. xv., 1879, p. 129.

of growing bones," and figures several specimens in which sequestra were discovered. Most commonly the necrosis involved the end of the diaphysis, epiphysial cartilage, and the contiguous part of the epiphysis. The first case published by him may be taken as typical of the rest.

Julius J., aged eleven years, was admitted into Abernethy Ward, under the care of Mr. Savory, March 4th, 1878. A week before he sprained his knee in coming from school, and a few days afterwards he complained of pain on the inner side of the joint. On admission the lower extremity of the left thigh was uniformly swollen, and there was increase of heat, pain, and tenderness above the knee on the inner side. Morning temperature $101^{\circ}6$; evening temperature 103° . The lower part of the thigh became more swollen; the knee joint filled with fluid, pus formed around the upper part of the articulation, and was let out by incisions; the febrile symptoms continued. December 6th, the following note was made: The knee joint is now destroyed; the tibia is displaced backwards, and the leg is in a position of extreme inversion. The position of the leg varied, sometimes being everted. The febrile symptoms were now severe, and amputation was only postponed until the acuteness of the inflammation had subsided. January 14th, amputation of the thigh was performed in the upper third. The patient made a good recovery. The examination of the lower end of the femur showed the epiphysis separated from the diaphysis, and displaced backwards. About three-quarters of an inch of the extremity of the diaphysis was necrosed. The lower third of the shaft was covered by a deposit of new bone, which was thickest on the posterior surface. Medulla infiltrated with the products of inflammation. The knee joint contained pus, and the cartilages were destroyed. Mr. Eve adds that "the inflammation in this case appears to have primarily attacked and spent its violence in the newly-formed bone at the extremity of the diaphysis."

Mr. J. Poland¹ published a case of suppurative arthritis of both shoulder joints in an infant, with necrosis of the osseous centre of the upper epiphysis of the right humerus. The child, eight months of age and healthy looking, was brought to Guy's Hospital with a swelling in the left axilla, which was considered to be an inflamed gland, the forefinger of the left hand having been slightly wounded five weeks previously. There was no history of syphilis. The axillary swelling only appeared on the day of admission. The temperature ranged between 100° and 104° during the next fortnight; at the end of this time the swelling had extended round the left shoulder joint, and some swelling was also noticed on the outer side of the right shoulder. Free incisions were then made into the abscess on the outer side of each joint, and the articulations opened. The child died five days later, at the end of the sixth week from the commencement of the swelling. The left shoulder joint was found freely opened, and in a state of acute suppuration, being full of pus, but the articular cartilage was as yet intact. A large portion of the outer and posterior aspect of the cartilaginous epiphysis of the head of the humerus was destroyed, exposing the posterior half of the upper end of the diaphysis and the osseous centre of the head, which were covered with vascular granulations. The right shoulder joint was more extensively destroyed than the left. The upper end of the diaphysis, except at the margin where the epiphysis still remained, was exposed and covered with velvety granulations, the osseous centre of the epiphysis, necrosed and yellow, was lying loose in the joint. There can be no question that very frequently in hip disease the lesion commences in the vicinity of the cartilage of conjunction, either on its epiphysial or diaphysial surface, or in the epiphysis itself, which often contains sequestra.²

¹ *Transactions of the Pathol. Soc.*, London, vol. xxxv., 1884, p. 327.

² Mr. G. A. Wright, On the value of determining primary lesion in joint disease as an indication for treatment, *British Medical Journal*, vol. ii., 1883, p. 419.

The subjoined are additional cases of necrosis, some of them occurring in unusual situations:—

NECROSIS OF TIBIA FOLLOWING SUPPURATIVE OSTEOMYELITIS;
SEQUESTROTOMY; CURE.

Case 16.—S. P., aged seventeen, a farm labourer, entered the Manchester Royal Infirmary, August, 1885. In following his occupation he often gets wet, and has to work in damp clothes for hours together. Sixteen months previously, he noticed one evening a stiffness behind his right knee; a swelling soon appeared occupying the whole leg from the knee to the ankle, and directly afterwards it gave way in three distinct situations along the front of the tibia, one opening being in each third of the limb, and all discharged freely. For some months before admission he had observed on several occasions small pieces of dead bone issuing from the sinuses. On examination we found a large sequestrum, quite black, formed of the greater part of the shaft of the tibia, exposed in the sinus situated on the middle third of the leg; the several sinuses were pouring out an offensive discharge, and the limb was very swollen. By connecting the sinuses while the patient was insensible, and removing some new bone, a large quantity of which had been thrown out, we extracted a large, irregular, spiculated sequestrum (*fig. 20*). The various prolongations were exceedingly fine, and great care had to be exercised lest some spicula should be left behind; the new bone was freely divided to enable us to carry out the necessary manipulations. The granulations lining the involucrum were removed with a spoon, and the cavity cleansed with chloride of zinc solution. After removal of the tourniquet very free hæmorrhage ensued, which, however, was stopped by the application of a warm (105° F.) antiseptic solution. The cavity soon filled with granulations, and when the discharge was diminishing skin grafts were placed on the surface. The process of cicatrisation was thereby materially hastened, and within a month the wound had quite healed.

OLD PERIOSTITIS AND OSTEITIS OF THE GREAT TROCHANTER;
NECROSIS; SEQUESTROTOMY.

Case 17.—John D., aged forty-nine, admitted into the Manchester Royal Infirmary, October 29th, 1885. About twenty-eight years ago he fell on the hip, which is now diseased, and soon afterwards a large abscess formed over the situation of the part injured. A few weeks later he became an in-patient at the Infirmary, where the swelling was freely incised. He left the institution after a week's stay, and since that time he has had no trouble until a couple of months ago, when he noticed a redness a little below the hip. As the part pained him he had it lanced, which treatment, however, left him much as he was before. Indeed, the area of inflammation tended to spread, and the discharge was very profuse. He has been confined to the house for some weeks, being quite unable to walk. The left hip presented much thickening, and in the centre of it was a small opening through which pus issued. The probe led into a cavity in the great trochanter, but no dead bone could be detected at the time. On laying the cavity open while the patient was chloroformed a sequestrum was, however, found at the back of the trochanter. It was removed without any difficulty, and the cavity, after being freely spooned, was plugged with oiled lint and wood-wool dressing applied. The discharge soon began to diminish and the cavity to contract; and at the time of his leaving the Infirmary there was every indication of the parts healing rapidly.

SINUSES IN THIGH, CAUSED BY NECROSIS OF GREAT TROCHANTER; SEVERAL
EXPLORATORY ATTEMPTS BEFORE THE SEQUESTRUM WAS DETECTED
AND REMOVED.

Case 18.—George B., aged twenty-seven, admitted into the Manchester Royal Infirmary, September, 1883. Had an injury to the right hip three years before, and ever since has suffered occasional pains in the trochanter. About twelve months ago an abscess formed and gave way on the outer aspect of the thigh, in the situation of the present sinuses. One sinus extends upwards for nearly five inches in front of the great trochanter, which is very much thickened. He was placed under the influence of chloroform and a counter opening made at the upper end of the sinus, which was found to extend forwards and backwards for a couple of inches; a careful exploration failed to detect any diseased bone, though its presence was strongly suspected. The sinuses were scraped and disinfected. The amount of discharge sensibly decreased after the operation, still it did not cease. Some months later a second exploration was made, and this time we were rewarded by finding a small sequestrum embedded in a cavity contained in the outer and lower part of the trochanter. It was removed, and within a fortnight the sinuses had finally closed.

NECROSIS OF THE PATELLA FOLLOWING ACUTE SUPPURATIVE PERIOSTITIS;
KNEE JOINT ONLY SLIGHTLY IMPLICATED.

Case 19.—Elizabeth A., aged eleven, admitted into the Manchester Royal Infirmary, September 9th, 1884. About six weeks ago she felt a sharp pain over the tuberosity of the left tibia soon after going to bed; it quickly spread over the knee, which became swollen. The pain she describes as being intense, and much worse at nights. Iodine was applied, and a few days later an incision was made into the swelling over the lower border of the patella. Pus escaped freely, and afforded immediate relief. There is no history of injury nor of any ill-health. The left knee was found much swollen, red, and hot, with some fluctuation in the joint; and thickening of the soft parts. No pain except on pressure. Over the patella there is a circular opening with exuberant granulations, and through the centre of it the bone can be seen bare and white, and evidently quite dead. A shell of bone from the upper and outer part of the patella was removed without any difficulty. The sequestrum measured an inch by half an inch. The cavity was lined with granulations, and healing went on in a normal manner. The dead bone had separated as an exfoliation, and no sheath of bone surrounded it.

NECROSIS RESULTING FROM THE ACTION OF PHOSPHORUS.

This form of necrosis, formerly a common affection, is now rarely seen. Soon¹ after the first employment of phosphorus

¹ Information obtained chiefly from Dr. Bristowe's elaborate report on the "Diseases incidental to the use of phosphorus," *Fifth Report of the Medical Officer of the Privy Council*, 1862, p. 176. First case of phosphorous necrosis in this country was published in *Guy's Hospital Reports*, 1846-7, 2nd series, vol. xii., p. 163.

in the manufacture of matches, it became a matter of common observation, more particularly abroad, that those employed in the match factories were liable to a peculiar affection of the jaws. Perhaps the first to call attention to the new disease was Dr. Lorinser,¹ of Vienna, who in 1845 published an account of twenty-two cases of jaw disease, of which the earliest had occurred as far back as 1839. He was soon followed by Heyfelder, of Nürnberg, and by Strohl, of Strasburg. The exhaustive work of Von Bibra and Geist,² which contained an analysis of sixty-eight cases that had up to that time occurred in Germany, was published in 1847, and was succeeded in 1852 by a further inquiry, by the latter of these authors, into the regeneration of the lower jaw after total necrosis.

In the reported cases the lower jaw was affected much more frequently than the upper. In thirty-nine cases the former was the seat of disease, in twelve the latter, and in five both the upper and the lower jaws were simultaneously or successively affected. The necrosis did not necessarily involve the entire bone even in the case of the lower jaw. The disease generally commenced with aching in one of the teeth. At first this was mistaken for an ordinary toothache and the pain would at times intermit. Sooner or later, however, recurrence of pain necessitated the extraction of the teeth, and the pain and annoyance for a time probably ceased. The wound in the gum, however, was found not to heal; offensive matter began to ooze from it, and before long a portion of the alveolus became exposed. Occasionally the portion of bone thus denuded came away, bringing with it perhaps one or two of the neighbouring teeth, and the disease made no further progress.

More frequently, however, the disease continued to spread; sometimes slowly, sometimes rapidly, more and more of the

¹ *Med. Jahrbücher d. K. K. oester. Staates*, 1845.

² *Die Krankheiten der Arbeiter in den Phosphorzündholzfabriken*, Erlangen, 1847. A résumé will be found in the *British and Foreign Medico-Chirurgical Review* for 1848.

jaw bone became denuded, the gums grew spongy and retreated from the alveoli, the teeth got loose and fell out, and the foetid suppuration became more copious; the soft parts around grew swollen, tender, infiltrated, and often the seat of sinuses. And thus the disease continued to progress till in the course of six months, a year, two years—it might be even five or six years—the patient sank from debility, septic pneumonia, or from some other consequence of the local affection; or having lost piecemeal or in the mass large portions of the upper or of the lower jaw, returned to his original state of good health, but the victim of a shocking and permanent deformity. During the earlier and more acute stages of the disease, constitutional disturbance generally showed itself, indicated by febrile symptoms, loss of appetite, thirst, and constipation; a sallow, pasty condition of the skin; and these were often associated with intense pain in the affected parts and consequent sleeplessness.

A considerable difference was observed in the progress of the disease in the two jaws. Thus in the case of the upper jaw it was noticed that the sequestrum was bare, and that no new bone was developed around it; that the process of necrosis was unattended by any, even the slightest attempt at repair. In the case of the lower jaw, on the other hand, it was almost invariably observed that after removal of the bone, a framework of new bone was left behind, often small and imperfect it is true, but still replacing and to a certain extent fulfilling the functions of the original jaw; and it was further observed that the dead jaw itself was clothed, especially below, with an imperfect layer of slightly adherent new bone. This latter appearance was considered to indicate that the disease was essentially and in the first instance a periostitis. From the symptoms and course of the case, which I have appended, the necrosis was mainly the result of a suppurative osteomyelitis, and the affection appeared to spread from the cancellous interior to the periosteum covering the body of the jaw.

It is generally supposed that the phosphorus fumes gain access to the jaw through the medium of decayed teeth. These two facts oppose the general adoption of this theory. It is observed that the existence of even very carious teeth among those who had been dippers for years does not ensure for them an attack of jaw disease. And moreover the necrosis has occurred in those whose teeth have been sound.

In one case reported by Sir James Paget¹ a man aged thirty-four was admitted into St. Bartholomew's Hospital for necrosis of the palatine and alveolar portions of both upper maxillæ. The whole of the necrosed bone was removed in one piece by the forceps. He had never been engaged in any business in which phosphorus was employed; but for three or four months previous to the commencement of his illness he had taken phosphorus internally, which he had been taught to prepare for himself, his method being uncertain, but always attended with the production of fumes. So far as could be ascertained, his teeth had been sound. He had never had syphilis or taken mercury.

The deleterious influence of phosphorus is exercised through one or more of its oxides—hypo-phosphorous acid, phosphorous acid, and phosphoric oxide—which are evolved copiously in match making, during the processes of mixing, dipping, and drying.

The direct application of phosphorus was the assigned cause in the first case of necrosis observed in Manchester. The patient, a man aged twenty-four, was a dipper and mixer. He had bad teeth, and to cure the toothache a Congreve-match was thrust into the hollow of one of those which were decayed, and to this the disease was attributed. The lower jaw became necrosed, and he died in the course of twelve or eighteen months from debility.

The precautions usually adopted to minimise the effects of

¹ *Medical Times and Gazette*, vol. i., 1862, p. 41.

phosphorus fumes were simple. They consisted in the ventilation and a proper arrangement and separation of the different departments of the manufacture, together with enforced cleanliness and the frequent washing out of the mouth with water containing alum or one of the fixed alkalies in solution. In Prussia a law was passed which prohibited the employment of persons with decayed teeth. None of these precautions can, however, equal in importance the substitution of amorphous phosphorus for the common variety previously in use. This has practically caused the disappearance of phosphorous necrosis.

Treatment.—Believing that the necrosis is largely due to suppurative osteomyelitis, the only treatment which is at all likely to succeed in checking the disease is the early and free removal of the portion of bone affected. Antiseptic washes must be frequently employed, and the general treatment should consist of nourishing fluid foods. When the bone is removed and the periosteum preserved, it is possible to have reproduction with perfect symmetry.

A case having an important bearing on this point is reported.¹ A female, aged eighteen, working in a match manufactory, had phosphorous necrosis which required the removal of a sequestrum. The operation was done by halves—one half being left for some weeks after the removal of the other. The patient recovered perfectly; died three years afterwards, and it was found that the lower jaw had been completely re-formed.

Mr. Warren Tay² reports a case of necrosis of the lower jaw in which nearly the whole bone was removed, and ten years afterwards he was able to record a very desirable amount of new bone formation.

¹ *Lancet*, vol. i., 1877, p. 813.

² *Trans. Pathol. Soc.*, London, vol. xxv., 1874, p. 204; also vol. xxxv., 1884, p. 281.

PHOSPHOROUS NECROSIS OF LOWER JAW; REMOVAL OF SEQUESTRUM; RETURN OF DISEASE; SUBSEQUENT REMOVAL OF THE REMAINDER OF THE BONE; RECOVERY; DEATH SOME MONTHS LATER FROM ASPHYXIA.

Case 20.—William R., aged forty-two, match dipper. About five weeks before admission into the Manchester Royal Infirmary patient had a bad toothache, and had three teeth extracted, after this he suffered a great deal of pain, and noticed the lower jaw gradually increasing in size on the right side. He had a large swelling in the right cheek, and complained very much of a constant aching in his jaw. Pressure on the swelling caused excessive pain, while at the same time an indistinct fluctuation could be discovered. It was also evident in the mouth where an incision gave exit to a large quantity of pus. Two months later the

FIG. 26. ✓

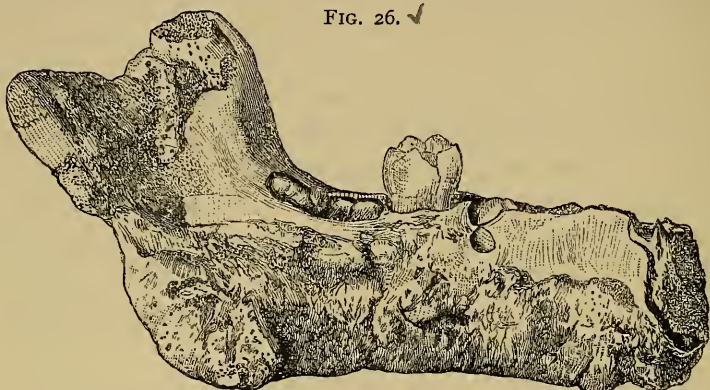


FIG. 26.—Phosphorous necrosis; portions of new bone adhering to sequestrum (*O. C. Museum*).

FIG. 27.

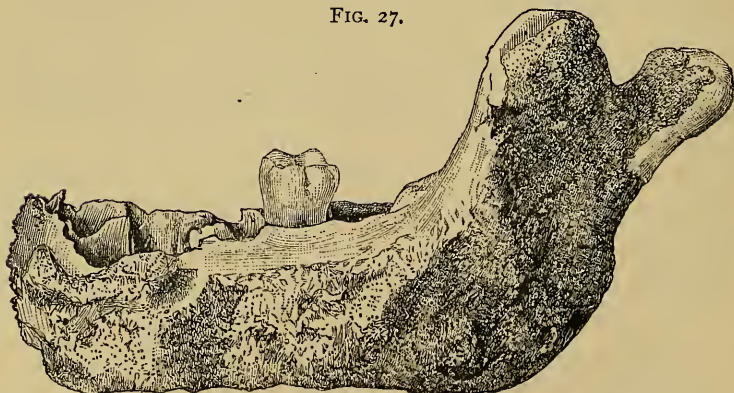


FIG. 27.—Phosphorous necrosis; the remaining portion of lower jaw removed. *Case of William R.* (*O. C. Museum*).

necrosed bone was removed from the outside, an attempt to do so through the mouth having failed. On right side the coronoid process was sawn through, while the second point of division was half an inch to the left side of symphysis menti; all the soft parts being carefully preserved. Immediately after the operation the discharge, instead of diminishing, became very profuse and of a dirty brown colour. This so exhausted the patient that he had to be fed by nutrient enemata every four hours. After the lapse of three months, during which there was some improvement in the general health, a second operation to remove additional necrosed bone had to be undertaken. This time the remainder of the jaw was taken away. The discharge from the large cavity that remained gradually diminished and the patient slowly convalesced. There was only very slight re-formation of bone. Owing to the matting together of the parts below the chin, the breathing became very embarrassed; he could not breathe with any degree of comfort when lying in the horizontal position; and sleep was impossible except in an almost erect posture. One day, about twelve months after he left the Infirmary, I received intelligence that early that morning he had died suddenly, and from the symptoms there could be no doubt the fatal result had been brought about by suffocation.

QUIET NECROSIS.

Quiet necrosis¹ is said to occur when the death of a bone, its separation, and the formation of new bone take place without any of the symptoms usually attending these processes. It almost appears certain that some of the older surgeons were familiar with this condition. Stanley² says that "when the bone attacked by necrosis is of small size, or only a small portion of it has perished, and in a patient who is not of an irritable habit, the inflammation which ensues in the surrounding soft parts is usually so mild that it gives rise to the effusion of fibrin or of serum without suppuration; the disease then passing through its several stages unaccompanied by any other change than the simple enlargement and thickening of the parts adjacent to the dead bone." Under such circumstances difficulty is often experienced in determining the nature of the disease, for it may then be doubtful whether the enlargement of the limb has been caused by necrosis, or by chronic inflammation of the bone, or by thickening of the periosteum, such as occurs in scrofulous children in whom the

¹ This term was first used by Sir James Paget in describing a case published in *Clinical Society's Transactions*, vol. iii., p. 183.

² *Diseases of the Bones*, 1849, p. 83.

periosteum of one bone or of several often becomes so much thickened as to produce an enlargement of the bone simulating that which is caused by disease in the bone itself.

Sir James Paget's patient,¹ a girl aged nineteen, was admitted into St. Bartholomew's Hospital in 1869. She was well nourished and muscular, and, except in being rather pale, looked healthy. Her complaint was of severe pain in the left knee, for which she had been under treatment for a month. The knee joint was very slightly swollen, with fluid in its cavity, but not hot or tender. What seemed more important was that a hard swelling, of which the patient knew nothing, nearly surrounded the middle of the shaft of the femur. This swelling, of nearly oval form and about six inches in length, was in every part very firm and tense; hard pressure on it was very painful, especially at its middle part. All the textures of the thigh appeared quite healthy; no part of it felt hotter than another; no veins or lymph glands were enlarged. The pulse was rather quick, but the breathing and temperature appeared natural. No signs of fever or general disturbance. In the belief that the swelling round the femur was due to periostitis, the patient was directed always to remain in bed, to take three grains of iodide of potassium three times a day. Blisters also were to be applied over the swelling often enough to maintain a constant slight inflammation of the skin. At first some benefit seemed to be derived from the treatment. Improvement of short duration; and for three months the condition of the affected part was almost exactly the same as when the patient was admitted. Periosteum over the principal and most tender part of the swelling incised. All the textures cut through down to the outer surface of the periosteum appeared perfectly healthy; there was not in any of them the slightest sign of inflammatory change. The periosteum was in the portion divided from one-third to half an inch thick, and in all its thickness

¹ *Loc. cit.*

dense, hard, white, and moderately vascular. Between the periosteum and the bone the incision laid open a flattened irregular cavity, from which a little blood-coloured fluid escaped, and was followed by the protrusion of some soft substance like coarse granulations. In this cavity, which was from an inch to an inch and a half in diameter, was a thin rough sequestrum separated from the wall of the femur, about an inch and a quarter long and a quarter of an inch wide. The walls of the cavity, of which the outer was formed by the thickened periosteum and the inner by the hollowed out surface of the femur, felt smooth and velvety, as if covered with granulations like those of ordinary cavities containing sequestra. The sequestrum appeared to be derived not from the outermost layers of the femur, but from layers just within them.

In another case, published by Sir James Paget,¹ a boy, aged thirteen years, had a large ovoid swelling round the upper part of the left humerus, which had slowly and painfully increased in size for about a year. It was thought most likely to be a firm medullary cancerous growth, but the doubts were sufficient to justify an exploratory incision. This was made through perfectly healthy textures till the periosteum was reached, this was found to be greatly thickened, and covering some cavities containing thickened and half-dried pus and several small sequestra which had separated from the wall of the humerus.

Reference is also made by Sir James Paget to specimens in the St. Bartholomew's Hospital Museum,² which illustrate the condition of quiet necrosis.

Mr. W. Marrant Baker³ records an instance of necrosis without suppuration in a man, aged twenty, who was quite well until about ten weeks before his admission into St.

¹ *Clinical Lectures and Essays*, Lond., 1875, p. 341.

² *Museum Catal.*, vol. i., sub-series A, No. 118, 110, Right femur and left tibia of same person, large portions of the inner layers of the walls of the shafts are completely separated after necrosis; but in the thickened outer layers surrounding the sequestra there are no openings for the discharge of pus.

³ *Med. Chir. Trans.*, vol. lx., p. 187.

Bartholomew's Hospital, when he began to suffer from deep-seated pain soon followed by slight swelling in the left thigh. Both the pain and swelling gradually increased, the pain being especially severe at night. About six weeks after the beginning of his illness, as the patient was walking across the ward, his leg suddenly gave way under him, and he fell; on subsequent examination it was found that the left leg was much shortened, evidently in consequence of a fracture of the femur in its middle third. Great pain was caused by all manipulation and still greater by any attempt to lift the limb. The case seemed to be one of malignant tumour of the femur, which had become the seat of so-called spontaneous fracture, and amputation at the hip joint appeared to be the best mode of relieving the patient. This was accordingly done. On making a longitudinal section of the femur, and of the condensed tissue which formed its immediate covering, a very unexpected appearance presented itself. It was plain that the disease from which the patient had suffered was necrosis of nearly the whole shaft of the femur. The dead bone was not loosened from its connections at all points. Near the trochanter it was still continuous with the cancellous tissue of the interior, and at the lower end of the bone, near the condyles, the same connection was observable. On the outer aspect of the sequestrum, dense and hard new bone had been produced from the periosteum, so as to form a moderately thick sheath, which closely enveloped the dead bone; so closely indeed that at some points it was difficult to make out any line of separation between them. At other parts the space between the new and the dead bone was occupied by a thin but tough membrane representing, Mr. Baker believed, the innermost layer of the periosteum. No inflammatory condition of the soft structures was observed, no abscess, no sinus, and not a drop of pus.

This case is considered to be one in which necrosis was the result of chronic inflammation of the bone. In such cases the necrosis presents many features which causes it to differ remark-

ably from the more ordinary forms of the disease, and especially from those in which the death of the bone has been caused by acute subperiosteal effusion or by conditions which quickly lead to it. In necrosis occurring in the course of chronic osteitis, suppuration is not, as a rule, an early symptom.

Another remarkable example of a central encysted sequestrum is recorded by Dr. F. Charlewood Turner.¹ The specimen, a left tibia, was removed from a woman, aged sixty-seven, who died from concussion of the brain. At the autopsy the left leg was observed to be much enlarged. The tibia was sawn through longitudinally; this exposed a sequestrum in the centre of the bone in its upper part, enclosed in a smooth walled cavity, having no communication with the surface. The cavity contained a small quantity of puriform fluid. The sequestrum was much eroded and about an inch and a half long and half an inch wide. It had no bony connections, and was made up of compact bone. Dr. Turner suggests that in the cancellous tissue of the enlarged bone in the situation of the sequestrum, osteosclerosis occurred from some impediment to the nutrition of the part, possibly referable to the bending of the bone, and that the part so affected subsequently became necrosed from arrest of its nutritive supply.

From the foregoing cases we may conclude that death of a considerable portion of bone may occur without the phenomena usually accompanying such a process, and that necrosis without suppuration may bear such a close resemblance to malignant disease of bone as to lead to some serious difficulties in diagnosis. It is very possible that quiet necrosis is the result of a series of changes, among which chronic inflammation, with hypertrophy and sclerosis, constitutes the earlier and more important.

¹ *Trans. Pathol. Society*, London, vol. xxxv., 1884, p. 283.

CHAPTER IX.

SYPHILITIC DISEASES OF BONE.

Bone diseases in connection with syphilis may be associated with the hereditary or with the acquired forms of the disease. I shall, in the first place, describe the lesions due to congenital syphilis, and afterwards treat of the affections which arise during the later stages of acquired syphilis.

BONE LESIONS DUE TO CONGENITAL SYPHILIS.

Through the researches of Wegner, Parrot, Taylor, Barlow and Lees, our knowledge of the syphilitic osseous lesions in infants and young children is fairly complete. The most characteristic changes are found in the bones forming the vault of the skull and in the long bones of the extremities. Wegner¹ published the first connected account of the pathological changes, but only described one form of the disease, the atrophic; and referred almost exclusively to the modifications which take place at the ends of the diaphyses of the long bones. Two years later Parrot² published his paper on the "pseudo paralysis" caused by an alteration of the osseous system in the newly-born, attacked with hereditary syphilis.

It is difficult to classify the lesions, as the changes which are produced vary so much. Certain parts of the skeleton are more frequently attacked than others; the disease is usually situated in the long bones, maxillæ, bones of the calvarium, ribs,

¹ Virchow's *Archiv.*, 1870.

² *Archiv. de Physiol.*, 1872.

scapulæ, and iliac bones; the vertebræ and the bones of the hands and feet being more rarely implicated. The lesions are of two kinds: 1. Atrophy of tissues already formed. 2. Formation of new products.

Two forms of atrophy are described: the first, which is the more frequent, found in the skull and in the limbs, Parrot¹ terms the gelatiniform, because the diseased structures resemble fluid jelly in appearance. The bone alters in colour; the marrow suffers a diminution in its cells, which finally disappear and are replaced by a vascular fibrillar network. When the bone proper is attacked it decalcifies rapidly, the lamellæ melt away, and large spaces are formed, in which a tissue resembling the altered marrow is found.

In the second variety of atrophy there is formed between the diaphysis and the cartilage of conjunction a thick layer impregnated with calcareous salts, described as ossiform tissue. Whenever this tissue exists in abnormal quantities it indicates an arrest in the process of ossification; the layer of cartilage in the immediate vicinity of the diaphysis, instead of being converted into bone, retains its cartilaginous condition, but becomes hardened from the deposit of calcareous salts. This calcified cartilage is much more brittle than normal bone, so that a fracture is easily produced, and the irritation induced by the rubbing together of the fragments may cause suppuration around the bone. The separation which occurs at the diaphysial extremities induce a powerlessness of the limb altogether peculiar and characteristic, termed by Parrot syphilitic pseudo-paralysis.

These cases are to be distinguished from paralysis of nervous origin by the electrical reactions of the muscles not being altered, and by the presence of projections in the neighbourhood of the joints when displacement of the osseous fragments exists. In 1865, some years before the appearance of

¹ *Trans. Pathol. Society*, London, vol. xxx., 1879.

Wegner's memoir, Cornil and Ranvier described separation of the epiphyses in new-born syphilitic children, and the histological lesions connected therewith.

The other variety of alteration in the bones of those who have inherited syphilis consists in the formation of new osseous tissue on the surface of the bones, changing their form and size, and often producing characteristic alterations. The new productions (osteophytes), whatever their density and structure,

FIG. 28. ✓



FIG. 28.—Periostitis of tibia, from congenital syphilis (*Mr. Wright's case*).

are found pretty constantly in the same situations. The humerus and tibia appear to be frequently attacked, the lower end of the diaphysis of the former and the internal surface of the latter, being the usual sites (*fig. 28*). On the femur the new porous bone is situated on the external surface, and on the scapula in the supra and infra spinous fossæ. The situation of the osteophytes in other bones appears to vary, usually corre-

sponding with that extremity of the diaphysis where growth is least rapid. The new bone is made up of trabeculæ, which are placed almost at right angles to the axis of the diaphysis, and may consist of one layer or of several distinguished by their colour and structure.

The changes in the cranium associated with hereditary syphilis are deemed so important as to merit separate consideration. Here gelatiniform atrophy appears to be rare, still it does exist, and Parrot alleges that it may commence during intra-uterine life. It occurs on the exterior, under the periosteum, and reaches the dura mater only when the disease is rapid and intense.

Cranial osteophytes are not produced simultaneously with the gelatiniform atrophy. The deposit of porous bone appears along the margins of the bones forming the anterior fontanelle, the osteophytes being separated by two grooves in the shape of a cross—one transverse, corresponding with the coronal suture, the other antero-posterior, following the sagittal suture. When the bosses are prominent and sufficiently extensive, the skull so deformed is typical, and designated natiform (bossy calvarium), owing to the resemblance between the bosses and the nates. The centres of ossification are always spared. Much less frequently the osteophytes are found on the forehead (*fig.* 29) and temporal bones, and in rare instances on the orbital plates and the occipital bone. The basis cranii was affected in one of Barlow's cases.¹ Cranial osteophytes gradually increase in size until by the addition of fresh layers the cranium is greatly increased in thickness, and even the sutures themselves may be bridged over, so as to produce premature union. The new bone originates in the deeper layers of the periosteum, and has spaces filled with connective-tissue corpuscles, provided with a certain number of prolongations, which communicate with one another and with the medullary spaces (Barlow). The osteophytes may become harder by the contraction of their

¹ *Trans. Pathol. Society, London*, vol. xxx., 1879.

medullary spaces, and by the accumulation of calcareous salts, in this manner the weight of the cranium will far exceed the normal limits (Parrot). The osteophytic growths appear within the first two years of life.

There is yet another peculiar change in the cranium in hereditary syphilis. This is a thinning of the skull in spots or larger areas, a condition known by the name of cranio-tabes. It is not unfrequently found in the parietal bones, near the

FIG. 29. ✓

FIG. 29.—Specific nodes on forehead (*Mr. Wright's case*).

lower posterior angles, or in the occipital bone; the change is most marked on the inner surface of the bone where conical pits are observed. In the affected portions the calcareous salts disappear, sometimes leaving only a thin membrane. The condition was first described in 1837 by Elsässer,¹ who erroneously regarded it as the cause of laryngismus stridulus. Usually

¹ *Ueber eine wiedernatürliche Verdünnung des Hinterhauptbeins bei einem Kinde.* Tübingen, 1837.

craniotabes is an infantile lesion, in rare instances, however, it has been seen as a foetal condition. Parrot has described the affection as occurring in premature still-born children, the pits being arranged round the anterior fontanelle; a distribution different from that which occurs at a later and the more usual period.

In the production of craniotabes certain factors appear indispensable. Pressure of the brain convolutions against the inner surface of the skull, the bones of which are soft and yielding from the effects of the specific disease, will undoubtedly cause absorption when on the outer side, there is a resisting body on which the head rests. These conditions are present in the situations where the thinning is most constantly observed, the posterior inferior portion of the parietal bones and, to a lesser degree, the occiput; the parts chiefly pressed upon when the child's head is lying on a pillow or is carried in the nurse's arms. To explain the exceptional instances where the craniotabetic spots are in the vicinity of the anterior fontanelle, Parrot offers the ingenious suggestion that in the ordinary position of the foetus in utero downward pressure would tell more on this part of the skull than elsewhere, so that, given the morbid condition of the bone, pressure on the inner surface would produce the effects observed.

The question is still unsettled whether or not craniotabes is to be regarded as exclusively syphilitic. Parrot maintained that it is, while other observers are equally confident that, although cranial osteophytes and spots of thinning are found in a marked degree in syphilitic infants, they are also encountered in those where there is no evidence of congenital syphilis, and where their rickety origin is almost certain.¹

The result of the specific process is different in the various situations in which ossification is taking place. At the extremity of diaphyses there is a marked arrest of development

¹ For further information and a clear exposition of the whole question, see Craniotabes, by Dr. T. Barlow, in Heath's *Practical Surgery*, vol. i., p. 383.

of new bone, and a tendency to breaking down of the newly-formed marrow; while on the surface of the shafts the redundant fibrillar tissue formed beneath the periosteum is frequently converted into bone and produces a thickening.

Mr. R. W. Parker¹ reports the following case of bone lesions in an infant, aged seven weeks, with snuffles, mucopurulent discharge from the eyes, papular eruption on its face, and mucous tubercles about the anus. Both elbows swollen and nodular from enlargement of the bones. Grating in right elbow owing to separation of lower epiphysis of humerus. Extremities of ribs considerably enlarged, also heads of fibulæ and lower extremities of tibiæ. Thickening around margin of anterior fontanelle, two small patches of craniotabes in parietal bones. Improvement under mercurial treatment. The child, however, wasted and died. Post mortem the following changes were found in the bones: *Left humerus*, lower extremity appeared thick; on making vertical section through it no separation of epiphysis from diaphysis as had been suspected, but between the two there was a lamella one line thick of soft gelatinous material, this gradually passed into the cancellous bony tissue of the shaft. Medullary cavity not well marked, its place occupied by a light spongy tissue containing dark red marrow. Lower half of shaft appeared as if encased in a sheath of new bone separated from the shaft by a narrow cavity containing marrow enclosed in delicate trabeculæ, upper extremity of the bone normal. *Left ulna*, periosteum stripped easily from shaft, its surface nodulated, most markedly in its upper third, also at the junction of middle and lower third. *Left radius*, upper two-thirds encased in a shell of new bone similar to that described in the humerus. *Right femur* periosteum not thickened, surface of bone not altered, dark line between upper epiphysis and shaft. *Right tibia*, as contrasted with other bones whole shaft appeared thickened; what appeared to be normal bone was

¹ *Trans. Pathol. Soc.*, Lond., vol. xxxi., 1880, p. 226.

ensheathed in a layer of new bone, between the two there was an interval which contained a delicate fibrillar structure filled with marrow. *Right fibula* nodulated and thickened like the ulna.

BONE DISEASES ASSOCIATED WITH ACQUIRED SYPHILIS.

Syphilitic affection of the periosteum and bone may be an early or a late symptom. When occurring during the earlier stage, the affection is often slight and transitory, and is constantly accompanied by other evidences of syphilis, such as skin eruptions, ulcerations of the throat or of the tongue. Should the bone lesions manifest themselves many years after infection, they often form the only symptom. Here we shall have to consider syphilitic periostitis and superficial osteitis, gummata in bones, and, in addition, the manifestation of syphilis presented in the bones of the face.

Syphilitic Periostitis and Superficial Osteitis.—The periosteum and bone are so intimately connected that inflammation can scarcely implicate the one without affecting the other. The patient will complain of pain and tenderness in a bone, such as the skull, tibia, or clavicle, before there is any appreciable swelling. Even at this early stage the periosteum is more vascular, and soon becomes thickened from infiltration with a small-celled inflammatory product, which also accumulates between the periosteum and bone (periosteal node). In this form of disease suppuration is rarely met with. When redness exists with formation of matter, the bone itself is seriously implicated, and the specific inflammation will almost inevitably terminate in caries (*fig. 30*) or necrosis (*fig. 31*). Specific periostitis is diagnosed without much difficulty. Besides the peculiar distribution of the disease, the bone affected is tender and painful, the pain being liable to exacerbations during the night (osteocopic pains). It may be mistaken for that form of periostitis connected with rheumatism, the pain of which, however, is erratic, and the joints are frequently affected at the same time.

Another manifestation of acquired syphilis in the osseous tissue is the formation of a bony node¹ (*fig.* 32). That is a tumour of some portion of the surface or substance of a bone

FIG. 30. ✓

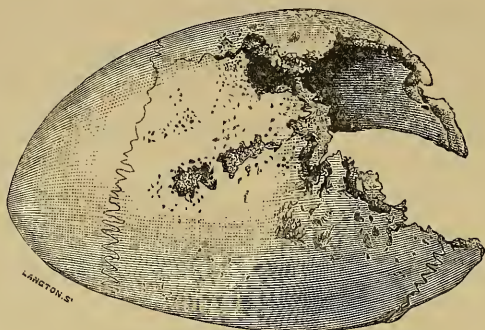


FIG. 30.—Syphilitic caries of the skull. Patient died of meningitis (*O. C. Museum*).

not usually very prominent, and with diffused margins. It is painful, particularly at nights; the pain not usually acute, but of a dull wearing character. The enlargement arises from the

FIG. 31. ✓

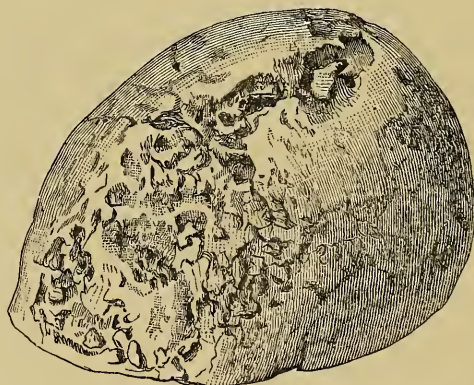


FIG. 31.—Syphilitic necrosis of the skull (*O. C. Museum*).

effects of inflammation on the substance of the bone as well as from the thickened periosteum over it. Less frequently a

¹ Hamilton, *Syphilitic Osteitis and Periostitis*, Lond., 1874.

specific node has a close, ivory-like structure, similar to that of an idiopathic exostosis, but it differs from the latter in having a broad diffused base. In some cases the whole thickness of a bone may be involved in the inflammation forming a partial hyperostosis. Early and proper treatment will usually remove all traces of a periosteal node; but if a node is large, hard, and of long standing, showing that the bone is more deeply implicated in a productive inflammation, the enlargement will often be permanent; clavicle, ulna, or the subcutaneous surface of tibia are not unfrequently thickened from this cause.

Syphilitic osteitis of the upper cervical vertebræ is a very serious disease; swelling of the anterior surface causes a projection into the throat, accompanied with dysphagia, and possibly symptoms of impending suffocation. The pain attending the disease is usually so severe that the patient keeps his neck rigidly fixed. Cure by ankylosis ensues or a further complication may arise. The swelling may trench upon the spinal canal and compress the cord or narrow the openings for the exit of the nerves, and so produce various forms of paralysis of motion or sensation.

Gummata of Bones.—Two forms are described, the first being well defined and having the consistence of a periosteal growth; the second infiltrating the osseous tissue, hence the name gummatus osteomyelitis given to it. The first or circumscribed form of gumma is often seen in the bones of the skull, where it appears in the first instance beneath the pericranium or above the dura mater, and sometimes simultaneously in both these situations. If the disease is permitted to go untreated the tumour increases in size, and soon the integument over it begins to redden, the skin thins



FIG. 32.—Syphilitic osseous node on the tibia (O. C. Museum).

and ulcerates, laying bare a yellowish substance, the gumma, which is breaking down. Some of the yellow, gelatinous material may come away, leaving a foul-looking ulcer, in which carious or necrotic bone is visible. The bone in syphilitic necrosis is often very slow in separating, and may remain exposed for years at the bottom of the ulcer (Hutchinson). Owing to this long exposure, combined with its roughened surface, the bone often presents a black appearance.

In the second form, described as diffuse gumma or gummatous osteomyelitis, the lesion is generally multiple, usually occurs in the long bones, and may exist in a latent state (Gangolphe¹). It is characterised by the porous, worm-eaten appearance of the bone, and by the reddish yellow colour of the material which fills the dilated medullary canal and intra-osseous cavities, and by the rarity of sequestra of any size. The yellowish substance is a fibrillar structure having in its meshes a large quantity of small cells, some of which are in a state of granular disintegration. At the periphery of the lesion there often exists a fibrous limitation. Gummatous osteomyelitis of the diaphysis often co-exists with an epiphysary syphiloma, which in its turn may be associated with a specific osteo-arthritis. Sometimes the syphiloma becomes encysted, and is surrounded by fibrous tissue and an eburnated zone.

Syphilitic osteo-arthritis is always secondary to an epiphysary or juxta-epiphysary syphiloma (Gangolphe). By degrees the disease implicates the diarthrodial cartilage, which is thinned, eroded, and finally perforated. As the number and size of the ulcerating perforations increase, the articular extremity becomes destroyed, the synovial membrane is thickened, and the joint becomes filled with a sero-purulent fluid. There is an absence of fungosities, and those parts of the cartilage which are free from disease are still adherent to the sub-

¹ *Revue de Chir.*, May, 1885.

jacent bone, contrary to what is seen in tubercular osteo-arthritis. After having destroyed the greater portion of an articular extremity, these lesions may cure either spontaneously or under the influence of anti-syphilitic remedies. Clinically specific osteo-arthritis is recognised by more or less marked deformity of the articular extremities, and occasionally by a swelling of the diaphysis, by an effusion into the joint of variable quantity and character, by the crackling, by the number of joints attacked, and by the relative chronicity of the lesions (Gangolphe). Operative interference is contra-indicated, as a cure is usually effected by proper specific treatment.

Syphilitic Disease of the Nasal Bones and of the Jaws.—

One of the most distressing forms of disease in connection with syphilis, inherited or acquired, is that which attacks the nasal bones. It commences as a gummatous deposit beneath the mucous membrane, and is often associated with similar affection of the palate. The nose becomes swollen, and from it issues a constant foetid discharge, which may also flow back into the pharynx. The bony and cartilaginous septum is destroyed, causing a depression of the nose which is very disfiguring. Pieces of necrosed bone may separate and be discharged through the anterior or posterior nares, or a hole may be formed in the hard palate by ulceration commencing in the floor of the nose. Through this opening the dead particles of bone may find a more ready exit than by the flattened nostrils (Hamilton). While this process is going on the foul discharge makes the breath extremely foetid and sickening, and the patient becomes a nuisance to himself as well as to others.

In addition to the general treatment mentioned below, the necrosed bone must be speedily removed with a small sequestrum forceps, and the foetor of the discharge corrected with the nasal douche (medicated with a very weak solution of carbolic acid or some other disinfectant) frequently used. In

the more severe cases a special proceeding may be resorted to with advantage. The operation devised by Rouge consists in turning up the upper lip and making an incision through the mucous membrane, at its reflection from the lip to the gums, from the pre-molar tooth on one side to a corresponding spot on the other. The tissues intervening between the mouth and the nasal cavities are now to be quickly divided, and the cartilaginous septum (if not already destroyed) detached from the anterior nasal spine. The finger can now be readily introduced into the nasal cavities, a careful exploration conducted, and the dead bone removed. After this is done the lip and nose should be replaced, care being observed that the base of the septum is placed accurately against and is supported by the nasal spine. No sutures are necessary. The deformity arising from destruction of the cartilage and skin of the nose may be remedied by a rhino-plastic operation. In the event of the perforation in the hard palate being large enough, the fragments of dead bone may be removed through it.

Syphilitic necrosis of the jaws is also a very distressing disease. The upper jaw is more often affected than the lower; portions of the alveolar border die, the teeth loosen, and the gums become red, swollen, and ulcerated. An exceedingly offensive discharge constantly escapes, the breath is rendered very foul, and the general health is seriously damaged. This form of necrosis is quite distinct and independent of any local action of mercury; it is a late symptom, and is not met with, even after salivation, in the earlier stages of syphilis. Many years ago mercurial necrosis, associated with ptyalism, used to be not uncommonly caused by the fumes of liquid mercury employed in the manufacture of looking-glasses. This form of disease has become almost if not quite extinct, since a plan has been introduced by which the mercury is chemically deposited on the glass. The local treatment of specific necrosis of the jaws resolves itself into the removal of the dead bone, even before it is separated, and the employment of antiseptic washes.

General Considerations respecting the Treatment to be Adopted in Syphilitic Bone Diseases.—When the lesion is associated with the secondary stage of syphilis and assumes the form of nodes, it is best treated by mercury, administered by the mouth, or introduced into the system by inunction or fumigation. Grey powder or blue pill, or calomel with opium, are among the best means of bringing the system under the influence of mercury. Salivation should be guarded against, as it is neither necessary nor desirable. Under the influence of this treatment, nodes will become less painful, and ultimately melt away. When the specific bone disease occurs during the later stages, either as a solitary symptom or in association with others, iodide of potassium is undoubtedly a very efficacious remedy. There are cases, however, where the iodide fails; in these mercury must be employed in small doses, and often it will be found beneficial to combine it with tonics. Mercury is also indicated in cases where the iodides are not tolerated.

In some rare instances, where the severe pain continued after the persevering use of these remedies, Hamilton, adopting the treatment which has been found serviceable in ordinary forms of chronic periostitis, found relief follow division of the thickened periosteum down to the bone. He records a case of osteitis and periostitis of the trochanter major, where severe relapse occurred after the patient had been relieved by constitutional treatment; permanent relief followed a free incision down to the bone through the thickened and indurated periosteum.

Hamilton relates another case of specific periostitis over the parietal bone, which resisted treatment by mercury and iodide of potassium, and where a free incision through the centre of the swelling down to the bone caused the disappearance of all pain. A soft node should not be opened, even when the soft parts covering it are inflamed and appear on the point of giving way; under appropriate treatment its disappearance may be ensured.

The bone lesions of inherited syphilis are cured by similar remedies to those employed in the acquired forms of the disease. Mercury is the most appropriate remedy in all stages of the disease. Not unfrequently nodes exhibit very little change for some time and then suddenly disappear (Hutchinson). When a node ulcerates, the denuded bone, having undergone hypertrophy and induration from the chronic inflammation which has attacked its substance, separates very slowly, and may remain *in situ* for many years. This peculiarity occurs in the acquired and inherited forms of syphilis, especially in the latter. This form of necrosis, arising from ulceration of a node, may be distinguished from that connected with other varieties of suppurative periostitis by the complete absence of any shell of new bone, owing to the destruction of the periosteum and soft structures covering it.

SPECIFIC NECROSIS OF LOWER JAW AND OF TIBIA.

Case 21.—Margaret McG., aged twenty-nine, admitted into the Manchester Royal Infirmary, January 14th, 1884. Up to nine years ago she was quite well; then a rash broke out on the forehead in the shape of red, circular patches. After this her throat became very sore, and soon a pain appeared in the left leg, with the formation of hard, red swellings over the tibia; after six months these commenced to ulcerate. All her troubles appeared after her marriage. About two years ago she received a violent blow on the right side of lower jaw, which soon swelled and abscesses formed, leading down to exposed bone. A piece of bone separated and came away through the mouth, bringing with it some of the teeth. She was an inmate of the Infirmary for a short time, and some more bone was taken away. Five or six weeks ago a piece of bone commenced gradually to penetrate the gum, and a week or so later several abscesses formed on the exterior. When admitted there were three sinuses leading down to diseased bone, and all discharging a small quantity of pus. A jagged piece of bone projects into the mouth, but it is not separated. On the anterior surface of the left leg, at the junction of the upper and middle thirds, there is a sinus at the bottom of which a portion of the tibia about three-quarters of an inch in diameter lies exposed. The sinus discharges and contains a wash-leather-looking slough. Above this sinus is a smaller one, also discharging, and there are several cicatrices of old ulcerations near the sinuses in various parts of the limb. Iodide of potassium ordered; sinuses to be dressed with iodoform. The parts soon presented a more healthy appearance, and granulations began to spring up. The greater portion of the right half of the lower jaw was necrosed and had to be removed. The sinuses on the face eventually closed, and the leg improved very much; the upper sinus healing, the lower one discharging very little.

Syphilitic Dactylitis.—This affection, first described by Taylor,¹ consists of a gummatous infiltration of the subcutaneous connective tissue, ligaments, periosteum, and bones of the phalanges. Irregular enlargements are produced in the fingers and toes, sometimes forming rounded swellings of the bone and periosteum in the vicinity of the metacarpo-phalangeal articulation, and having a strong resemblance to the chondromata not unfrequently encountered in the same situation. In other cases there is a more extensive swelling occupying the sheaths of the tendons and the subcutaneous tissues, producing a brawny thickening of the entire finger. These affections are very manageable, and quickly disappear under the exhibition of syphilitic remedies.

¹ *Amer. Journ. Syph. and Derm.*, Jan., 1871.

CHAPTER X.

TUBERCLE IN BONE OR TUBERCULAR OSTEITIS.

Syn. CASEOUS CARIES. SCROFULA IN BONE.

It will be necessary before we pass on to the consideration of tubercular disease of bone to discuss very briefly the nature of tubercle, and the relation which it bears to scrofula. And here I will at once say that I recognise no essential difference between the tubercular and scrofulous diseases of bone, and in considering them I shall employ the term tubercular as being preferable and less likely to lead to confusion.

Tubercular osteitis is characterised by the deposit of tubercles in the osseous tissue, where they undergo changes similar to those observed in tubercle in other structures, the bone, meanwhile, showing evidences of a grave lesion. A more simple form of tubercle than the grey granulation, hitherto regarded as the most elementary form, is now described; this is the tubercular follicle or scrofuloma, a small nodule made up of cells imbedded in a delicate reticulum; a giant cell occupies the centre of the nodule, and constitutes the first zone; immediately outside this is a layer composed of a number of epitheloid cells, while still beyond this second zone are found a number of round lymphoid elements, some of which may be in process of epitheloid transformation (*fig.* 33). A cluster of these follicles forms what has been called the grey granulation.

The tubercular nodule in bone, as elsewhere, after attaining to a certain stage of development, undergoes retrogressive changes, owing to its lack of blood-supply, caseous, fatty, and necrotic changes being observed.

An affection is stamped as tubercular when the diseased tissues possess the typical structure alluded to above, and the bacillus tuberculosis is present. Another test relied upon is inoculation, which in true tubercular disease gives distinct and definite results. Certain clinical phenomena will also indicate the tubercular nature of a bone disease, its slow insidious course often unattended by fever, commonly ending in caseation and suppuration, the abscess possessing the characters usually associated with the cold or tuberculous abscess

FIG. 33. ✓

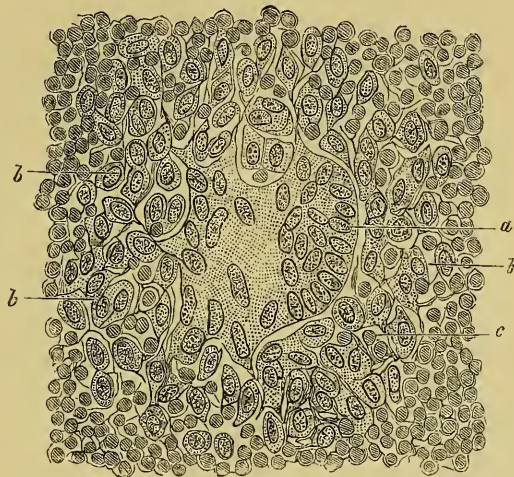


FIG. 33.—Tubercles in fungous granulations of bone. *a*. Giant cell.
b. Epithelioid cells. *c*. Lymphoid cells (Ziegler).

in the soft parts, in addition to which we have the not infrequent hereditary taint—members of the same family being attacked by different manifestations of the diathesis.

Whether scrofula is to be looked upon as an incipient form of tuberculosis, or as a separate diathesis in which there is a marked tendency to certain diseased processes, and especially to caseation, is still a disputed point. Many competent observers are in favour of the former view, and regard tuberculosis as a disease characterised by the appearance of an

adult tubercle or the grey granulation, while in scrofula the tubercular follicle or embryonic tubercle alone is found, both conditions, however, being due to the presence of the special bacillus.

We are now in a position to follow the phenomena presented by tubercular osteitis in its various stages. Tubercle usually makes its appearance in the cancellous texture of the long and short bones (*fig. 34*), but its special habitat appears to be the bodies of the vertebræ, where it constitutes the

FIG. 34. ✓

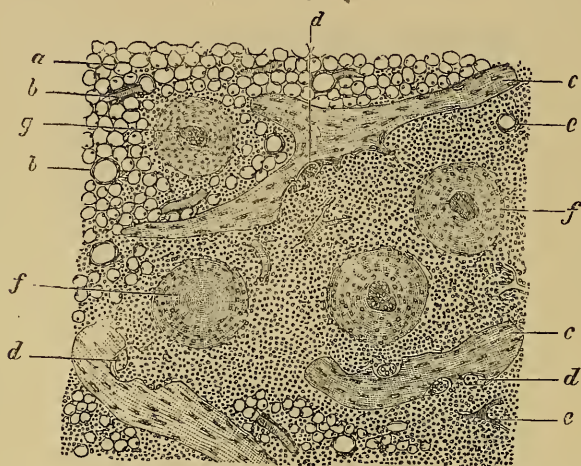


FIG. 34.—*a*. Medulla with fat cells. *b*. Blood-vessels. *c*. Bone. *d*. Osteoclasts. *e*. Granulation tissue. *f*. Tubercles within the granulation tissue. *g*. Isolated tubercles (*Ziegler*).

ordinary form of Pött's disease (*fig. 35*), the sternum, and the ribs. It rarely attacks the diaphyses of long bones; an exception must, however, be made in the case of the smaller cylindrical bones—such as the metacarpal and metatarsal bones and phalanges—where tubercular osteomyelitis (strumous dactylitis) is very common. A solitary tubercle in bone, itself a rare and unimportant disease,¹ which may, how-

¹ Cornil is said to have discovered tubercles in the bones in about a third of the cases of phthisis which he examined, although no symptoms pointing to implication of the osseous tissue were present during life.

ever, constitute a small part of a general tuberculosis, appears as a semitransparent, circular spot with an opaque centre, quite bloodless, and often with a somewhat irregular border; the surrounding bone medulla being of a deep red colour. The junction of several isolated tubercles forms a mass of granulations, having a greyish, granular, semitransparent aspect, or if

FIG. 35. ✓

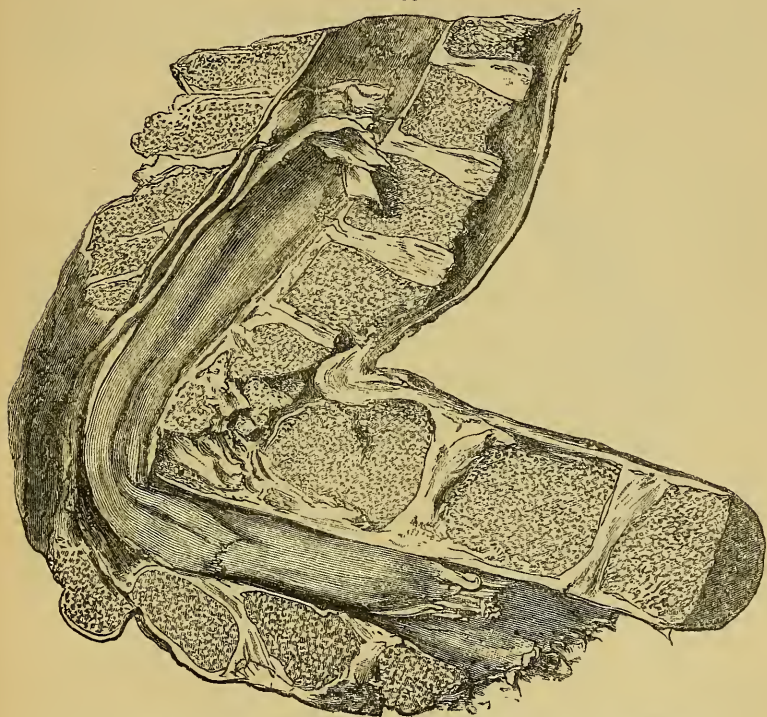


FIG. 35.—Tubercular disease of bodies of vertebræ, posterior curvature (Pott's disease) (*O. C. Museum*).

the disease is of long standing the patch presents a decidedly caseous appearance. At the periphery of such masses the medulla is observed to contain no fat cells, its blood-vessels are dilated, and no longer have connective tissue around them; this appearance suggesting that osteitis preceded the deposit of tubercles (Cornil and Ranvier).

When tubercular granulations develop in bone they produce obliteration of the existing blood-vessels, and this leads to caseous degeneration, for the same reason that infarcts become caseous. These slowly progressing, caseous patches, often preceded by a chronic osteitis, and terminating in supuration with softening and destruction of the proper bone tissue, are very characteristic of bone tuberculosis; and there is every probability that the majority of the examples of caries associated with caseation are really tubercular in their origin.

By crushing the contents of one of these caseous foci between the finger and thumb, we find a certain number of small bone particles (König¹), or even sequestra of appreciable size; these diseased centres are separated from the surrounding bone by a layer of granulations in which, unless the caseous change is too advanced, undoubted tubercles may be detected. The distinction between these caseous tubercular foci and the small inflammatory centres found in epiphysial osteitis is not always very obvious. In the granulations which accompany ordinary inflammation, no tubercles are found; but in their place will be discovered the remains of pus corpuscles, granule cells, and fat detritus. Occasionally the caseous tubercular foci undergo a further change and form cretaceous masses, which remind one of similar masses having a like origin in the apices of the lungs.

Tubercular necrosis possesses some peculiar features. Unlike the necrosis which follows acute inflammation of bone, the sequestrum resulting from tubercular disease usually preserves some point of attachment to the bone (König). The topographical distribution and appearance of this variety of necrosis are also characteristic. It is usually localised in the spongy epiphysis and articular ends of long bones, in the bodies of the vertebræ, and in some of the flat bones, such as

¹ *Die Tuberculose der Knochen u. Gelenke*, Berlin, 1884.

the pelvis, scapula, cranium. In the articular extremities the sequestrum assumes the shape of a wedge, with the base directed to the neighbouring joint,—in the disease of which it often plays a very important part,—while the apex looks towards the medullary canal (*figs. 36, 37, 38*). Between the sequestrum and the healthy bone immediately surrounding it there intervenes a layer of firm tubercular granulations which join it to the bone, and which frequently circumscribe the disease. Sequestra having the appearances described may

FIG. 36.✓

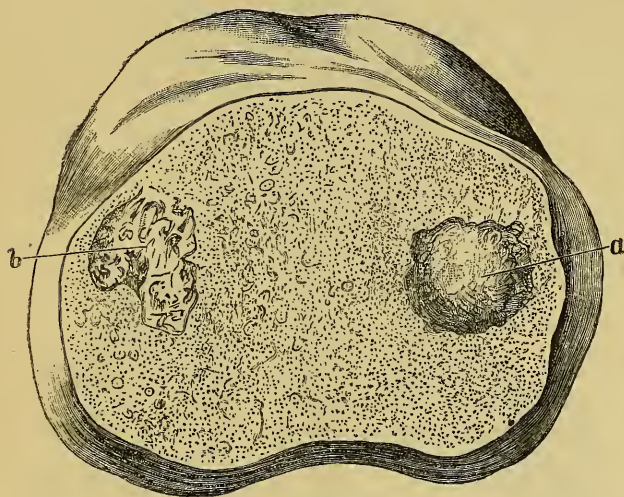


FIG. 36.—Transverse section of tibia near the knee. *a.* Granulating centre.
b. Porous sequestrum (*König*).

remain *in situ* for a considerable period, and there may exist the appearance of a complete cure. In the event of this happening, the sequestrum will be attached to the bone by a dense connective tissue. The presence of such a sequestrum may provoke a thickening of the bone from periosteal new productions.

König¹ divides bone tuberculosis into two chief classes—(1)

¹ *Loc. cit.*

the dry form, where there is a tendency to cicatrization, and (2) a soft variety, terminating either in caseation or in suppuration. The dry form is characterised by the presence of tubercular nodules having a tendency to become transformed into a cicatricial tissue, a condition unfavourable to the local extension of the disease. In the second variety the vegetations often degenerate into a soft, grumous detritus, which shows a disposition to infect the tissues in their immediate vicinity. To these two

FIG. 37. ✓



FIG. 37.—Cuneiform sequestrum in the lower end of the tibia, its base directed towards the ankle joint (*König*).

forms may be added a third and a rarer form, in which there is progressive infiltrating tuberculosis of bone, the disease appearing in the spongy tissue of the bone, in the adjoining compact layer, and sometimes penetrating the marrow in the central canal. In this variety, which has no proper limiting barrier, the lesion penetrates the healthy bone in the shape of irregular islets of a yellowish or yellowish white colour. In the medul-

lary cavity it may form foci of suppuration of varying sizes, or the disease may spread widely; constituting true suppurating tubercular osteomyelitis.

A large number of the joint affections designated white swellings arise from the development of one or several of the tubercular foci in the interior of the osseous articular ends, or more rarely the affection originates in a synovial tuberculosis. In some instances tubercle may develop concurrently in both

FIG. 38.

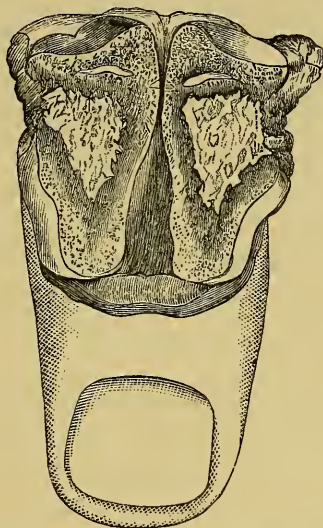


FIG. 38. —Longitudinal section of the first phalanx of great toe, showing a cuneiform sequestrum (*König*).

the synovial membrane and the articular extremities, or tuberculosis of the latter may lead to diffuse miliary tuberculosis of the neighbouring articulation.

The presence of tubercle bacilli in bone and joint tuberculosis is often difficult to determine. Koch and others have found them, but the diligent researches of some competent observers have proved unsuccessful. Our inability to discover the bacilli must not be regarded as a proof of the non-tubercular character of certain lesions observed in the

bones and joints. Generally the microscopic appearances, together with the clinical history, are sufficiently characteristic to mark the tubercular nature of the changes even should the micro-organism not be found.

Primary tuberculosis of cartilage is a disease which is unknown; but when the tubercular foci occupy the bone tissue immediately underneath the cartilage, the latter often undergoes absorption (König¹).

Bone tuberculosis may be primary or secondary, appearing only when there is already advanced tuberculosis in other organs. A large proportion of the cases of tubercular osteoarthritis are secondary; out of sixty-seven cases old foci were found in fifty-three (König). Metastasis often occurs in a bone or joint after lung disease, or after tuberculosis of the genito-urinary tract. Such a history as the following is not uncommon: a patient has an attack of lung disease; during convalescence, after perhaps a slight traumatism, a swelling forms at the articular end of a bone, and terminates in a cold abscess, and when this gives way or is opened the bone disease is revealed.

Osteal form of tuberculosis is very frequent in the hip joint, and König's observations coincide with those made by Volkmann, as regards the frequency of the disease in the acetabulum.

Tubercular disease, either in the olecranon or condyles of the humerus, is a fruitful source of elbow-joint disorganisation. Out of fifty-two cases the osteal form of tuberculosis was observed in forty-two, and of these twenty-two commenced in the ulna, most frequently in the olecranon (König). In tuberculosis of the elbow, anything short of a complete resection gives only very unsatisfactory results. The functions of the resected joint can scarcely be compared with those of a healthy articulation, yet they are infinitely superior to those after a cure without resection.

¹ *Loc. cit.*

Course and Termination of Tuberculosis in Bone.—Local tuberculosis may cure, and does not necessarily tend to a general infection which ends fatally. A good result has been obtained in all the varieties of bone disease associated with tubercle. It is produced generally, only after the destruction of the part involved, and by the formation of cicatricial tissue. This mode of termination is most frequent in that variety of the disease where there are firm granulations and few tubercles, less frequently in those where there is caseous softening and suppuration. In tubercular necrosis the presence of cuneiform sequestra directly hinders the process of cicatrization. It is important to remember that the cure may be incomplete, the disease remaining in a latent form and easily called into activity again by an external agency, such as an injury. It is very necessary to bear this in remembrance when we make any attempt to straighten tubercular joints that have remained in the same position for many weeks or months; diseased foci in such cases are readily rekindled, often with the most deplorable consequences.

General Treatment.—Among the therapeutic means which exert a beneficial influence on the course of tubercle in bone, absolute rest of the part holds a foremost position. Its influence is particularly required in that form of the disease in which there is a great tendency to softening and suppuration. We should combine with rest, counter-irritation in the form of iodine paint or blisters, and also in the early stages the application of uniform compression. The actual or thermo-cautery may be usefully employed in the earlier stages of the disease, and more especially when pain and the other symptoms of chronic osteitis are prominent. Generally malposition of the diseased limbs must be corrected. Residence at the seaside is very desirable; and cod liver oil with iodide of iron should be administered.

When the disease affects the spine, rest in the horizontal supine position is the best method to adopt; in the early stages, when attended with much pain and the disease occurs

in young subjects, enforced rest carried out in this manner should be combined with tonics and hygienic treatment calculated to improve the general health. When the affection pursues a more chronic course, Sayre's jacket or some suitable mechanical appliance must be adopted.¹

König states the rule in regard to operative intervention in the following terms: "The surgeon should interfere in tuberculosis of bones and joints only when the local condition demands it, and the fear of secondary general tubercular affection does not constitute a sufficient indication." It is highly probable that constitutional infection is often favoured, if not directly provoked, by the operation and by it alone. Every large focus in a bone, in the vicinity of a joint, if it can be diagnosed, is however cured only by operation; and the proper procedures to adopt are those already discussed under caries, where we also mentioned the necessary constitutional treatment. The difficulty will be in diagnosing the exact extent of the bone lesion. That form in which wedge-shaped sequestra exist usually escapes recognition until a fistulous track forms, leading down to the dead bone. The symptoms resemble in most particulars those mentioned as existing in articular osteitis.

Tubercular Periostitis or Strumous Node.—Here the chronic inflammation is induced by the presence of tubercles in the periosteum. The symptoms are those already mentioned under chronic periostitis. A localised periosteal pain, increased by pressure, with a circumscribed, firm enlargement, which at a later period softens as the pus forms. At the margin of the diseased patch new osseous tissue is produced by irritation of the osteogenic layer of the periosteum. In the early stages the disease may subside; generally, however, the swelling softens, the products make their way to the surface, perforate the skin, and grumous pus often containing caseous masses is

¹For a complete account of the various methods of applying supports in spinal caries, see Mr. Golding Bird, article in Heath's *Practical Surgery*, vol. i., p. 233.

discharged externally. The lining membrane of the abscess is covered with exuberant granulations, in which tubercles are found. The disease may be observed in almost any bone, but it is peculiarly prone to attack the articular ends of the bones of the lower extremities. It is also frequently observed in the ribs.

The treatment consists in counteracting the tendency to scrofula by the remedies already mentioned. The pus is to be evacuated as soon as it forms, and the cavity freely spooned. Iodoform locally applied will be found very efficacious, so also may the use of the thermo-cautery.

Strumous Dactylitis; Spina Ventosa.—This affection, which is a tubercular osteomyelitis, is observed in the diaphyses of the small cylindrical bones of the hand and foot. It is confined to the period of childhood, and its scrofulous or tubercular nature is generally admitted. A syphilitic form of dactylitis, originating in a gummatous periostitis and sometimes terminating in necrosis, has already been described.

The tubercular variety of dactylitis consists of a chronic enlargement of a finger or toe, fusiform in shape, and almost painless, due to rarefaction and disappearance of the bone with the formation of a new osseous shell from the periosteum. The cavity is filled with caseating granulations, which break down and suppurate. In some rare instances nearly the whole of the bone may disappear without any suppuration, leaving a shortened finger or toe. More frequently the soft structures covering the diseased bone become swollen, red, and an abscess forms, which ultimately gives way. A sinus is formed through which necrosed bone may be detected and is sometimes expelled.

The treatment of this affection is tedious and often unsatisfactory, the mere removal of the diseased marrow rarely sufficing. Complete extirpation of the bone, with preservation of the thickened periosteum, offers a better chance of success. I would advocate the free removal of the newly-formed osseous

wall on one side, with exposure of the medullary cavity, which is cleared of its diseased marrow, and plugged lightly with iodoform gauze. This plan of treatment has answered well in cases of disease of the first metatarsal bone, and yields better results than subperiosteal resection, which is often disappointing from the small amount of bone which is reformed. This latter procedure, moreover, is in most cases unjustifiable, as the amount of necrosis is often very limited. It sometimes happens that during the course of a strumous dactylitis, an attack of acute tuberculosis or of tubercular meningitis supervenes, killing the patient in a few days. Such a result happened in a little girl admitted into the Manchester Infirmary with strumous dactylitis of the metacarpal phalanx of the right middle finger. While waiting a few days for operation, she developed symptoms of tubercular meningitis, which rapidly proved fatal.

Tubercular Bone Abscess.—That many chronic bone abscesses originate in a deposit of tubercle can no longer be doubted. The necessity for destroying whenever possible the membrane lining the walls of such abscesses will be evident when it is remembered that in its substance will be found tubercles in various stages of development. This can be effected by removing it with a Volkmann's spoon, or, where this is not practicable, injecting the sac with a strong solution of carbolic acid or a solution of iodoform in ether, so largely and successfully employed in the treatment of cold abscesses in soft structures.

Tubercular osteitis is generally attended with suppuration, and differences of opinion exist in regard to the advisability of opening such abscesses. When situated near a bone which is easily accessible and where the disease can be exposed and successfully removed, the propriety of laying open the sessile abscess cannot be questioned. This treatment is not so applicable to the migratory abscess, in which the seat of the osseous lesion is far removed, as, for example, is the case in psoas abscess connected with disease in the lower part of the

dorsal spine. Lannelongue is opposed to the practice of non-interference in such cases until the abscess appears near the surface, and he adds that a cold abscess is to be opened as near the seat of the osseous lesion as possible.

The size of a cold abscess connected with tubercular disease of bone bears no necessary relation to the extent of the osseous lesion. In the spine this is often observed, the bone affection may be limited, and yet the abscess originating in it frequently spreads far and wide. The contrary is also true, extensive disease in the vertebræ leading to marked deformity in the spinal column, with scarcely a trace of suppuration. In the latter class of cases we often observe a caseous form of tubercular disease which stops short of the formation of an abscess.

When, therefore, a bone abscess is superficial and increasing in size, exhibiting a tendency to come to the surface, an opening may be made into it, and at the same time the lining membrane of the abscess and the tubercular focus in the bone are freely scraped with a spoon. It is only by these means that we can hope to excite the formation of a healthy granulating surface. Iodoform is to be freely insufflated into the cavity; or the latter is plugged with gauze impregnated with iodoform, the same treatment is to be repeated at each dressing, or as a substitute iodoform pencils are introduced into the cavity.

The treatment to be adopted in the congestive or migratory abscess is more difficult to indicate. The risks attending its spontaneous opening are such that this event should be anticipated, and in favourable cases when the extent of bone disease is limited we may hope the cavity will after a time contract and cicatrise. The opening must be made as near the seat of origin of the disease as circumstances will permit, and even the actual lesion, in the spine, for example, whence a large number of these abscesses come, may be attacked. The cavity, after the opening is made, is distended with a warm antiseptic solution consisting of carbolic acid (1 in 30) or sublimate (1 in

3000), and a large drainage tube introduced. The wood-wool dressing is to be renewed as often as the quantity of discharge renders it necessary. Of late the plan of treating cold abscesses, whether originating in the soft parts or in bone, by the injection of a five-per-cent ethereal solution of iodoform has been strongly advocated by Professor v. Mosetig-Moorhof, of Vienna, who introduced it, and by Verneuil. It is said that large abscesses have cured after two or three injections.

In this connection must be also mentioned the syphon drainage plan introduced by Dr. Robertson, of Oldham,¹ which appears to be peculiarly adapted for large, cold, migratory abscesses connected with spinal caries. While the patient is anæsthetised an incision is made into the abscess cavity, and a large drain tube filled with carbolic acid solution (1 in 20) inserted; the other extremity of the tube is placed in a bottle containing an antiseptic fluid, occupying a position below the level of the patient's body. The pus begins to flow as soon as the operation is completed, and the cavity is gradually emptied without the production of any constitutional disturbance.

PHTHISIS; TUBERCULAR ARTHRITIS OF LEFT ANKLE JOINT; TEALE'S AMPUTATION OF LEG; RECOVERY FROM OPERATION; DEATH THREE YEARS AFTERWARDS FROM THE CHEST AFFECTION.

Case 22.—Emma M., aged twenty-three, admitted into the Manchester Royal Infirmary, January 6th, 1883. She has suffered from phthisis for nearly three years, and a cavity exists in the apex of the left lung. Five months ago she noticed that the skin over the left external malleolus was dark coloured and that the ankle was swollen. No pain at first, but soon it came on and prevented her from standing; her heel became drawn up, and the toes pointed. Various applications to relieve the pain were tried. A month later a localised swelling appeared over the external malleolus, and the whole joint became excessively painful. Patient is very anæmic and emaciated, and found to be in an advanced state of phthisis. A fluctuating swelling exists just below and behind the left external malleolus. The whole ankle is puffy and rather painful on movement. The heel can, however, be percussed without causing pain. The joint was fixed in a plaster bandage with a window opposite the abscess, which was opened antiseptically. She was sent in a few days to the Convalescent Hospital and remained there about five weeks, then returning to the Infirmary. The ankle was still much swollen and

¹ *Medical Chronicle*, vol. i., No. 1.

very painful. There was a sinus over the external malleolus which communicates with another one an inch below this point. There was a very evident swelling over and around the internal malleolus completely obscuring this bony point. T. 101°. An incision was made into the abscess on inner aspect of the joint where it was about to break. Pain in the ankle became worse, and was so severe as to prevent sleep. Is anxious to have the limb removed if there is any chance of relieving her suffering. The condition of the chest deemed highly unfavourable for the administration of the anæsthetic. The operation was, however, decided on, and, contrary to what was anticipated, chloroform was borne very well. Teale's amputation was performed in the middle third of the leg. Recovery uninterrupted and quick, and with a good stump. The condition of the chest remained the same, apparently uninfluenced by the operation. Tubercles were found in the articular extremity of the tibia, which was denuded of cartilage. Patient died after the lapse of three years of the chest affection.

TUBERCULAR DISEASE OF THE LEFT ELBOW JOINT, COMMENCING IN THE OLECRANON; RESECTION; RECOVERY; FISTULA IN ANO; DIVISION OF SPHINCTER; RECOVERY.

Case 23.—W. W., aged thirty-five, admitted to the Manchester Royal Infirmary, May 30th, 1883. Father living, aged seventy-five. Mother dead, cause not known. One sister died of consumption. Patient has had inflammation of the lungs twice; an interval of seven years elapsed between the first and second attacks. Five years ago, while shoeing a horse, he was kicked, his left elbow coming violently against the wall of the smithy. He took no notice of the injury and resumed his occupation, but in about six months he found that it hurt him to employ a file which he was in the habit of using at his work. He then consulted his club doctor, and was under his care for two months, during which there was scarcely any change in his arm. He now went to a bone-setter and remained under him for ten months with no improvement. An abscess formed near the olecranon at the seat of previous injury. When admitted he was a well-made, muscular man, fairly healthy looking. The elbow was much swollen and felt hard and puffy in places, and the skin presented several scars, the result of old incisions. Over the olecranon was a sinus discharging a quantity of thin, slightly sanguineous fluid, and a probe led into a diseased centre in the olecranon. The joint was evidently in a state of hopeless disorganisation. There was also unmistakable evidence of consolidation at the left apex. The joint was excised by a posterior longitudinal incision. The cartilage covering the ulna had completely disappeared, and the bone in the immediate vicinity of the caseous cavity had undergone sclerosis; the other articular cartilages were healthy. The pulpy synovial membrane was removed with forceps and scissors and a Volkmann's spoon. The whole proceeding was conducted antiseptically. Not much suppuration, but convalescence somewhat tedious. Ultimate closure of wound with the exception of a small sinus on the posterior aspect where the drainage tube had been. About two and a half months after the operation the condition of the chest became more troublesome, he complained of pain in it, and the cough was much worse. Dulness was now found at the right apex, together with crepitation, tubular breathing, and increased vocal resonance. He was sent to the Convalescent Hospital at Cheadle, remained there a month, afterwards went on a prolonged visit to Scotland. During the whole of this time he was

taking a pill of quinine, digitalis, and opium, and cod liver oil whenever he could manage it. He improved very much after this, and soon he was able to inform me that he had increased his weight by nearly a stone. There was a corresponding improvement in the condition of his chest and the appearance of the elbow, which had now soundly healed. For the next twelve months, with the exception of one or two drawbacks in the shape of superficial abscesses in the elbow cicatrix, he continued to improve. About that time he began to complain of uneasiness about the anus. A superficial ischio-rectal abscess formed and opened spontaneously, leaving a fistula, which was divided. This healed, and now (December, 1886) he is in the enjoyment of such good health that he is able to follow his employment as a blacksmith, not working much himself, but superintending the work of others.

TUBERCULAR ABSCESS IN HEAD OF LEFT TIBIA; TREPHINING; TEMPORARY RELIEF; SUBSEQUENT DIRECT IMPLICATION OF THE KNEE JOINT; AMPUTATION THROUGH THE THIGH; RECOVERY.

Case 24.—William B., aged forty, admitted into the Manchester Royal Infirmary, October 29th, 1884. He does not remember any previous illness, and the family history is free from any hereditary tendencies. About five years previously he sprained his left knee. Soon afterwards, while he was sitting at his work, he felt a severe pain over the inner side of the head of the tibia, which was followed by a swelling of the knee joint. The pain continued, and was distinctly worse at night, and occasionally extended down to the toes. During the last three years the knee has been occasionally very much swollen; a decrease in the swelling would, however, take place when the limb was rested. The pain in the tibia was always present, and was of a shooting, darting character. He has had various applications at different times, and although they have relieved for a time, a cure had not been obtained. The left leg is somewhat wasted, slightly everted, and flexed at the hip and knee. The knee is much swollen and of a globular shape, with the skin red, tense, and hot. There is a very tender spot over the inner tuberosity of the tibia, where there is severe pain on pressure. There is also a cold abscess over the left sacro-iliac joint. On November 4th, patient put under chloroform and a vertical incision an inch and a half in length made on the inner side of the head of the tibia, and the tissues, which were much thickened, divided until the bone was reached; the periosteum was then cleared from the bone for a small space and the trephine applied. As soon as the centre pin penetrated the bone pus welled out, and the circle of bone removed was infiltrated with pus. The cavity situated in the head of the bone contained about a teaspoonful of yellow serous pus. The lining membrane was carefully removed with a spoon, and a drainage tube inserted, the whole proceeding being conducted antiseptically. The bone bordering on the cavity appeared to be sclerosed. The very next day a note was made of a diminution in the pain, which completely subsided in five days. Three weeks later it was observed that the cavity had contracted very much and that the discharge was very slight. The knee swelling did not, however, diminish as it ought to have done. By the middle of December it was noticed that the knee joint was very much distended with fluid, and pressure over the front of the articulation induced some pain. Fluctuation was very distinct in all directions. As the patient complained of more aching in the head of the tibia, another exploratory operation was conducted by making a longitudinal incision on the inner side of and

below the tubercle of the tibia, and circle of bone removed with a trephine. The bone was soft and very spongy. The wound immediately filled with a sanious, oily-looking fluid. As much as possible of the diseased bone was now removed, and in doing so the old and new cavities were made continuous. Nearly the whole of the interior of the head of the tibia was thus removed. The leg was dressed as before. The discharge after the second operation became very abundant. The knee soon began to give more trouble; the pain and swelling increased, and the neighbouring structures inflamed. The temperature, which up to now had rarely exceeded 99° , rose to $101^{\circ}8$ and even 102° , the patient at the same time becoming restless and expressing himself as being much weaker. Amputation of the thigh was performed on January 11th, 1885, a little more than two months after the first trephining. The patient slowly convalesced.

CHRONIC TUBERCULAR DISEASE OF SEVERAL BONES; REPEATED
OPERATION; RECOVERY.

Case 25.—Fritz P., aged nine years. Healthy parents. Two brothers, one older and one younger, in the enjoyment of good health. The elder lad has, however, occasional attacks of asthma. No history of any hereditary disease in the family. The disease commenced nearly eight years ago with painful swellings on the head and over each superior maxillary bone at its junction with the molar. There was some fever, and suppuration soon took place, leading to the formation of sinuses which communicated with necrosed bone. About this time I saw him, and remember being very much puzzled with the case. The cause of the bone disease appeared involved in obscurity. There was an absence of injury, and no traces of syphilis or struma could be detected. After the disease had been in existence for a period of six months, chloroform was administered and sequestra, each the size of a shilling, removed from the parietal bones. They included the whole thickness of the skull, and after their removal the pulsations of the brain were distinctly visible. Subsequently sequestra were also removed from the superior maxillary bones. The suppuration in these situations began to diminish very soon, and within a few months the sinuses had closed, and in the skull dense cicatricial tissue replaced the bone that had been lost. The disease now attacked the right humerus and right radius, also the left tibia; tender swellings, some softening, appeared, these gave way and disclosed carious disease of the bones mentioned. In the humerus the lesion situated near its lower end involved the elbow joint, which became slightly swollen and stiff, afterwards becoming firmly ankylosed. In both the radius and tibia the disease assumed the form of tubercular osteomyelitis, attacking the diaphyses and involving almost their whole extent. The spine also became diseased, leading to very marked angular curvature in the upper dorsal region. He also had caseous lymphatic glands over the right parotid and in the neck below the margin of the lower jaw, likewise a softened nodule in the right epididymis. The treatment has been antiscrofulous remedies, fixity of the diseased limbs, recumbent posture for nine months when the spine was affected. It might be mentioned here that while this existed an abscess appeared on the right side of the spine, between the fifth and sixth ribs, and that the boy coughed up a small porous sequestrum, evidently a portion of a vertebra. The tibia and ulna have been repeatedly scraped with a Volkmann's spoon, and the cavities cleansed with a carbolic solution (1 in 20), and iodoform insufflated into them; the tubercular glands

have also been freely spooned. The lad has spent several weeks each summer at the seaside, and has always returned much improved in health. He is, of course, considerably deformed, but is now in the enjoyment of good health. All the sinuses with one exception, that over the tibia, have healed, and he is able to join in games and to walk a considerable distance without fatigue. The cicatrices on the neck show a disposition to break down and occasionally give trouble. Looking at this case in all its bearings, I have no hesitation in submitting it as one of bone tuberculosis which, after the lapse of many years, has advanced very considerably towards a cure. The urine has been repeatedly examined, and so far the prolonged suppuration does not seem to have affected the kidneys injuriously. There is one other point of interest. Neither in the diseased tibia nor in the radius has there been any appreciable formation of bone from the periosteum, in this respect forming a marked contrast to the acute inflammations affecting the diaphyses in young subjects. This bears out what Stanley¹ says: "Even the most disorganising and destructive processes of scrofula in bone are of slow progress and unaccompanied by the inflammatory changes in the periosteum which in other diseases of bone are followed by osseous deposits on its surface." The case exemplifies very well the duration of treatment in scrofulous affections of bone; it also shows that however extensive the disease may be the prognosis is not altogether hopeless, provided the patient enjoys the prime necessities in the treatment of scrofula—good food and plenty of fresh air.

A case² which is more remarkable even than mine has lately been recorded. A boy, aged twelve, had thirty-five operations performed within a period of seven years, on account of tubercular bone affections. Most of them were on the lower extremities; nearly all the metatarsal bones were successively attacked by tubercular caries. In one foot the metatarsal bones and part of the os calcis had to be excised; the other foot had to be amputated. Caries of the ribs occurred, and the vault of the skull became the seat of various tubercular changes. In consequence of this, symptoms of pressure on the brain supervened, and required energetic treatment. The periosteum was elevated, and the diseased portions of bone chiselled away. It was now observed that perforations of the parietal bones had occurred in two situations. Between the inner table and dura mater extensive granulations and yellow caseated masses had developed. The sharp spoon, therefore, had to be freely used. Similar changes in the frontal bone had not perforated.

¹ *Diseases of the Bones*, London, 1849, p. 248.

² Israel, *Deutsche Med. Wochenschrift*, 1886, No. 6.

Nearly at the same time a tubercular focus appeared at the base, near the styloid process. Free exposure and scraping produced a cure.

Volkman,¹ in calling attention to the tubercular bone affections of the skull formerly described by Nélaton, terms them perforating tuberculosis of the bones of the vault of the skull.

The differential diagnosis between the effects of syphilis and tubercle on the bones of the skull is not always easy. The subsequent course of the disease and the concomitant symptoms will assist us very materially in interpreting correctly the nature of the lesion. The tubercular affection generally commences with the formation of a cold abscess, which on being opened gives issue to a puriform fluid, usually containing caseous masses. The walls of the abscess cavity are lined with granulations, in which caseating tubercular nodules are discovered. The bone at the bottom of the cavity is anæmic or already dead, the process involving the entire thickness of the skull. In some cases the bone is already perforated, and a fistulous track leads into the interior of the skull. Occasionally the retention of inflammatory products within the cranium causes serious symptoms necessitating the use of a trephine.

TUBERCULAR OSTEITIS, WITH NECROSIS OF THE ILIUM.

Case 26.—Charles P. C., aged thirty, a law student, admitted into the Manchester Royal Infirmary, 12th September, 1884. For some years he has lived in America, and came to this country for a change. Father died at eighty-four; mother also about the same age. There is a history of chronic disease of the lungs which has existed for many months. About four years ago he fell off a horse, on his right side, which is the one now diseased; felt little or no inconvenience from the accident. For fourteen months has had pains which resembled those of sciatica. The actual cautery was applied. After a time an abscess formed on the right buttock; a second abscess, which was opened antiseptically, appeared a little higher in the position of the present sinus. Three months later bare bone was found, and a sequestrum about the size of the tip of the little finger removed. The

¹ Volkman, *Centralblatt für Chirurgie*, 1880; also *Internat. Soc. Rec.*, N.Y., 1880, i., p. 74.

sinus would not heal, and continued to discharge freely. Condition on admission : Over the crest of the ilium and about the centre of it there is a sinus leading down to necrosed bone which has not separated. The discharge amounts to about an ounce of pus daily. Dulness, with jerky breathing and some crepitation at the left apex. Expansion of the right side of chest better than the left. A few days after admission he was placed under the influence of the chloroform mixture, and the sinus examined with a probe. It extended downwards in the direction of the great sciatic nerve to a point behind the great trochanter, where a counter opening was made. A long drainage tube was passed through the sinus after it had been carefully scraped. Some bare bone near the crest of the ilium was freely gouged. After this there was some febrile disturbance, the evening temperature reaching 102° . It, however, only lasted three days, a decided improvement then setting in. The discharge diminished and the appetite began to improve. During this period the chest affection remained quiescent, the cough troubling him only very occasionally. In October he was sent to the Convalescent Hospital at Cheadle, from whence he returned to the Infirmary on December 22nd, 1884. General health much improved. Sinuses in gluteal region present a healthy appearance and discharge about an ounce of pus daily. On exploration of the upper sinus, bare bone still to be felt. Urine s.g. 1025, reaction acid, alb. none, sugar none, deposit nil. December 29th, Temperature rose last night to $101^{\circ}4$. Patient complains of pain in the buttock shooting down along the course of the sciatic nerve. The sinuses look healthy, and the lower one appears inclined to heal. There is a diminution in the amount of pus. January 6th, 1885, Temperature very irregular, the evening before last it rose to $101^{\circ}2$; during the day time it remained about normal. Discharge still less, and the sinuses show a tendency to close. On the 17th he was placed under the influence of an anæsthetic, the upper sinus enlarged and three small sequestra were removed with a forceps, and several minute fragments scraped away, the wound plugged, and dressed with wood-wool. T. on the morning of operation $99^{\circ}4$, in the evening $103^{\circ}6$. January 18th, M. T. $101^{\circ}6$, E. $103^{\circ}2$. Wounds syringed out with sanitas solution. 19th, M. T. $98^{\circ}6$; discharge abundant; much less pain in dressing. 21st, M. T. normal. Morphia injected subcutaneously at night; eases his pain; not much sleep without it. Profuse sweating. Discharge abundant from upper wound, none from the lower one. February 5th, T. since last report has been generally about 100° ; last night it attained its highest point, $102^{\circ}4$; this morning it is 101° . Patient has become more anæmic and weaker, suffers from a severe pain in the affected buttock. Sleep has been very disturbed. A peculiar and disagreeable odour is perceptible on going near the patient, so that it was deemed advisable to suspend a sheet saturated with strong carbolic lotion at the foot of his bed. Hæmorrhage has occurred from the wound frequently during the last few days, so it has had to be plugged with iodoform gauze. The sensitiveness of the granulating surface is very great. After this date he began slowly to improve, so that by March 7th the wound had nearly healed up. T. generally normal. He relishes his food and is gaining strength very decidedly. He left the Infirmary very much improved and returned to America. This patient died of albuminuria some two years later, during which time his condition varied much. The sinuses on the buttock discharged very little, and the bone affection appeared to be cured. No disease could be detected with a probe.

NECROSIS, PROBABLY TUBERCULAR, OF THE STERNUM AND RIBS.

Case 27.—Thomas McG., aged twenty, admitted into the Manchester Royal Infirmary, August 13th, 1884. Father and mother living and healthy; three brothers and two sisters also healthy. No history of phthisis in the family. Patient was playing cricket and received a blow on the chest from the ball; this was followed in about a month by a hard, painful swelling, which was lanced, letting out a considerable quantity of pus. He has a strumous appearance. There is a great deal of thickening on the right side of the chest, especially in front of the nipple, where a dull sound is elicited on percussion. Over the area of about four cartilages (4 to 7) there are several sinuses; one above, on the middle line of sternum, allows the passage of a probe, which reaches dead bone. Two inches below this and a little to the left of the median line there are two sinuses, one of which leads to diseased bone. About an inch to the left of the right nipple and two inches below it there is another sinus, and a probe introduced into it passes up and to the left and reaches bone which is thought not to be diseased. He was placed under the influence of chloroform and all the sinuses scraped; at same time soft carious bone removed. After this the parts appeared more healthy, the sinuses discharged less, and when he left the Infirmary there was every prospect of ultimate healing taking place.

CHAPTER XI.

ACTINOMYCOSIS OF BONE.

Another form of specific parasitic bone disease has been described of late years; it was first recognised as such in the jaws of cattle by Bollinger;¹ up to this time the affection having been regarded either as a scrofulous disease or as osteosarcoma. Human actinomycosis, first identified by Dr. Israel² and afterwards by Professor Ponfick,³ is an infectious disease due to the action of a fungus called, from its form, after the suggestion of Harz, the actinomyces.

The growth consists of a mulberry-like mass, with small yellowish bodies thickly interspersed in it, about the size and having the appearance of millet seeds; microscopically it consists of a granulation tissue, with minute abscesses in which the specific fungi are found; these consist of closely-interwoven masses of threads, from which pass out a number of threads in a radial manner, that divide dichotomously and are enlarged at their ends.

Hitherto the disease has been described chiefly in connection with the jaws, the lower one being most frequently affected; its origin is rarely central, most commonly the outside of the lower jaw being attacked.

Dr. Israel described the first and, so far as I know, the only case in which the disease originated centrally. Two

¹ *Centralblatt f. die Med. Wissensch.*, 1877, No. 27.

² *Klinische Beiträge zur Kenntniss der Aktinomykose des Menschen*, Berlin, 1885. This is a collection of Israel's writings on Actinomycosis, and contains his latest cases.

³ *Die Aktinomykose des Menschen eine neue Infectiöse Krankheit*, Breslau, 1877.

months before coming under observation, a female patient, aged forty-six, noticed a slight tenderness on the outer side of the right lower jaw. The cause was supposed to be a small swelling at the junction of the gum and the buccal mucous membrane, which, however, on repeated puncture and incision, neither discharged pus nor disappeared. In January, 1884, no swelling was visible externally, but a thickening of the lower edge of the right lower jaw could be felt midway between the angle and the symphysis. All the teeth in the upper jaw were absent; the three anterior molars and the canine tooth were absent in the lower jaw on the right side, and the atrophied alveolar processes were covered with mucous membrane. The second lower incisor on the right side was carious. A tumour about the size of a small cherry was immovably fixed to the external surface of the lower jaw, at a spot corresponding to the position of the first two absent molars. It was covered by the mucous membrane of the cheek and lip, and had an elastic pseudo-fluctuating feel; on its summit was a capillary opening, from which a drop of fluid could be pressed and through which a probe could be passed deep into the lower jaw-bone. An incision was made through the tumour, and the cut surface showed a thick peripheric layer of a red colour, below this there was a soft, golden-yellow speckled substratum. When this had been scraped away, an opening was noticed in the outer surface of the lower jaw, through which a small sharp spoon was passed into a large cavity in the bone, filled with the same golden-yellow speckled soft tissue. This when removed was found to be thickly crowded with granules of actinomyces. A more radical operation had to be performed a month later. The skin was divided along the edge of the lower jaw and the periosteum detached; the cavity in the bone was enlarged by removal of the external wall with the chisel, and the contents, consisting of yellow-speckled granulation tissue, containing spicula of bone and granules of actinomyces, was scraped out, and the most prominent part of the tumour

removed. In the bottom of the cavity, firmly fixed in the depth of the cortical substance of the bone, was found the fang of the canine tooth. A complete and lasting cure was effected.

The disease in this remarkable and unique case commenced in the centre of the lower jaw, expanding it, and eventually perforating the external wall. There appears to be a distinct causal relationship between caries of the teeth and the development of submental actinomycosis.

The following case, also recorded by Dr. Israel, is of interest in this connection. The patient, a merchant, aged twenty-four, suffered for a year from a tumour in the left maxillary region, which varied in size from time to time, and occasionally even seemed to disappear entirely. When examined the tumour extended from a finger's breadth below the angle of the left jaw to the hyoid bone, being like a hard string to the touch, and fluctuating only at its lower end. The last left molar in the lower jaw was carious, all the other teeth being sound. At first the hardness was situated close to the angle of the left lower jaw, and gradually became separated from this point and moved downwards. The periosteal swelling commenced at that portion of the lower jaw which corresponded with the carious molar. On incision a little fluid was found, and this contained actinomyces. Healing ensued after scraping. The case exemplifies a peculiar characteristic of the disease, viz., the travelling downwards from the jaw to the neck.

When the disease invades the upper jaw it travels forwards to the face, also towards the base of the skull, owing to the anatomical relations of the bone. From the base of the skull the disease may pass along the front of the spinal column until it reaches the mediastinum, or it may extend upwards and invade the brain. It will be evident therefore that the prognosis is much more serious when the actinomycotic affection is situated in the

I am indebted to Dr. Hime's translation in the New Sydenham Society's *Selected Essays on Microparasites in Disease*, 1886, for references and cases connected with actinomycosis.

upper than in the lower jaw. Wherever found actinomycotic tumours are mainly composed of granulation tissue in various stages of fatty degeneration, and scattered through it will be found the peculiar fungi or actinomyces. The disease is of slow progress and generally occasions very little pain. Owing to the formation of cicatricial tissue in some portions of the growth, a partial spontaneous healing may take place. While this exists in one part of the tumour, extension is going on at another from progressive cell-proliferation. Softening may also occur, leading to the production of pus and the establishment of a fistula.

Treatment.—The diseased tissue must be completely removed, either with a spoon or, in severe cases, by excising the portion of bone in which the morbid process is going on.

CHAPTER XII.

RICKETS.

Syn. RACHITIS.

A constitutional disease, common in large towns among children belonging to the poorer classes, and occurring during the period of most active growth—namely, the first years of life. It is characterised by disturbances of nutrition and altered physiological action in the bone-producing structures—the epiphysial cartilage and periosteum; together with an interruption, more or less complete, in the deposit of bone salts in these tissues. Although rickets is met with much more frequently among the poor of large towns, it is not by any means confined to this class. Merei¹ gives it as the result of his personal observations in Manchester, that one child in every five (seventeen in eighty-six) in families in comfortable circumstances presented symptoms of rachitis. Whether the disease is observed so frequently as this may be open to doubt, but those who see much of children's diseases will admit that rickets is encountered in quarters where we least suspect it. Equally true it is that this affection may exist for some time before the symptoms are correctly interpreted: the cutaneous hyperæsthesia, the fretfulness, and profuse perspirations being attributed to other and erroneous causes.

The disease usually commences within the first two years of life, it has been observed in the foetus, and may occur in children of seven or eight years (Jenner).

Causes.—A predisposition to rickets is no doubt inherited,

¹ *Disorders of Infantile Development and Rickets*, 1855, p. 171.

this is shown in many ways; the disease may be directly transmitted from parent to child, or again, several members of the same family may suffer from rachitis, although the conditions which usually produce the disease are absent. Feeble digestion and imperfect assimilation, fruitful sources of rickets, are unquestionably hereditary, and the child of a tubercular syphilitic or otherwise enfeebled parent is more likely to become rachitic than those of healthy and robust ancestry.¹

Food unsuitable to the child's age and digestive powers constitutes a very general and powerful cause of rachitis. The amount of ignorance that exists among mothers generally, in regard to the manner of feeding their children, is truly appalling. Nothing is more common than to administer a food far beyond the child's powers of digestion or to continue suckling a much longer period than is at all beneficial for mother or child. Insufficient and unsubstantial maternal milk supply, and artificial foods of inferior quality or inappropriate to the age and development of the child, are productive sources of rachitis. It is said² that rickets has been produced artificially by the continued administration of very minute doses of phosphorus, together with the simultaneous withdrawal of lime from the food. Virchow suggests that the prime factor in the production of rachitis is the use of food deficient in calcareous salts. It is difficult to understand how the omission or limited employment of lime salts could induce the changes in the epiphysial cartilage and periosteum so characteristic of rickets. Besides errors in diet, there are other conditions which exercise an important influence in the production of rickets. Among these may be mentioned unhealthy surroundings, over-crowding, ill-constructed and badly-ventilated houses, want of fresh air, and absence of sunlight.

¹ Ashurst, *Internat. Encyc. of Surgery*, article, Rachitis, by Dr. J. L. Smith, vol. i., p. 251-275.

² Senator, Ziemssen's *Encyc.*

Some regard syphilis as the direct source of rickets; this is only partially true. Syphilis, like many other affections, may so impair the health of the parents, especially the mother, as to lay the foundation for rickets in the offspring.

In rachitis three distinct periods may be observed. The first, in which the bones are not deformed, is marked by proliferation and altered nutrition of the cartilage and periosteum; in the second there are considerable and special deformities; while the third period is characterised by condensation of the rickety bones.

In order to appreciate the histological changes observed in the earlier periods of rickets, it is necessary to refer very briefly to the normal process of ossification. A long bone grows in length from the epiphysial cartilages, and an increase in circumference is produced by the changes in the deeper or osteogenic layer of the periosteum. In the proliferating zone of the epiphysial cartilage, or that layer of it which is nearest the bone, the cells swell, while the capsules surrounding them become spherical. Each cell then divides into two cells, which again subdivide until eight or ten cells instead of one are observed, each surrounded with a capsule and enclosed in a common capsule. This is distended by the cell multiplications, and elongates by reciprocal pressure so as to converge towards the point of ossification (Cornil and Ranvier). These cell groups, surrounded by the capsules and about to undergo ossification, overlay the end of the diaphysis. The zone in which these proliferating changes are observed constitutes a narrow line, visible to the naked eye, as a bluish, semi-transparent layer covering the end of the shaft, and situated between the osseous and cartilaginous tissues. In rickets the zone of proliferation is observed to have increased in thickness, the change implicating nearly the whole epiphysial cartilage. The primary capsules are much larger, and instead of enclosing eight or ten cells, as in the normal condition, they often con-

tain from thirty to forty cells. The region in which these proliferating changes are going on, and which forms the characteristic swellings near the articular ends, constitutes a soft, broad layer, having a grayish translucent look. Coincident with these changes we observe an arrest in the transformation of the proliferating cartilage into bone; though we see attempts in this direction in the spicules of bone springing up from the bony substratum of the shaft and in granules of lime scattered through the cartilage (Dr. J. L. Smith).

Changes are also observed in the deeper layer of the periosteum. In the normal state, during the circumferential growth of a bone, a soft vascular tissue is formed on the under surface of the periosteum, and is changed into bone by the deposit of lime salts. At the commencement of rickets the subperiosteal layer of medulla is transformed into a soft connective tissue, which, at a more advanced period, becomes more solid. It adheres to the under surface of the periosteum and to the surface of the bone, so that the two cannot be separated, which is generally easily done in young subjects (Cornil and Ranvier). The changes already described in the epiphysial cartilage and periosteum are more closely allied to those observed in inflammation; and the most probable hypothesis regarding the cause of rachitis is that which refers it to inflammation of these structures (Niemeyer), and the condensation rather than normal ossification which closes the rickety process may be justly regarded as a termination of the inflammation in osteosclerosis.

After the rachitic disease has lasted some time, and while the bones are soft and yielding, deformities will commence to make their appearance, and in their production the weight of the body and to a certain extent perhaps the action of the muscles play an important part. The bones of the lower extremities are most frequently affected, and here we meet with characteristic distortions. The tibiæ are curved outwards or outwards and

forwards in their lower third. Occasionally these bones are compressed laterally, the shin forming a sharp and prominent anterior curvature. The thighs, when deformed in the lower third, project forwards and outwards, sometimes inwards. The bones of the upper extremities are much less frequently affected, the humerus (near insertion of deltoid) more often than the bones of the forearm. In most cases the ligaments are weak and yielding, and produce a looseness of the articulations which in the knee materially assists in the establishment of genu valgum.

In the cranial bones important changes occur at the edges, which correspond with the epiphyses elsewhere. Proliferation of the cartilage cells produces a thickening, which is made up of soft and porous bone, and in some cases bulges above the surface of the neighbouring bones. A rachitic head is larger than a normal one, but its size appears greater than it really is owing to the growth of the facial bones being retarded. In seventeen non-rachitic children, with an average age of 6.05 years, average circumference of head was 19.95 inches. In the same number of rachitic children, average age of 4.72 years, the average circumference was 21.22 inches.¹ Delay in the closure of the fontanelles is constantly observed in rachitic subjects. Normally the anterior fontanelle should close about the eighteenth month of life; when rickets is present it may continue membranous until long after this period, often up to two and a half, three, and even four years of age.

Chronic hydrocephalus may also interfere with closure of the fontanelle, and as the two diseases require very different treatment and necessitate dissimilar prognosis, it is important to distinguish between them. Chronic hydrocephalus causes a bulging of the fontanelle, while in rachitis the membrane is flat or even depressed. In the one case pressure from within interferes with the closure, and in the other the non-closure is due to a deficiency in the deposit of lime salts. As already mentioned, a

¹ *Lancet*, vol. ii., 1880, p. 1017.

rachitic head is rather larger than a normal one; it also has other characteristic peculiarities. It has a more or less square shape, with a flat top and narrow projecting forehead, and in the parietal regions it is very prominent. The condition known as craniotabes, first described by Dr. Elsässer,¹ is also frequently observed. Here the cranial bones are thinned in places so that the brain is destitute of proper support; the affected bone being occasionally no thicker than parchment, and crackling when pressure is made upon it. The factors requisite for the production of craniotabes, and its relation to bone syphilis and rickets, are discussed in a former chapter (see syphilis of bones). Craniotabes is believed by many to hold a causative relationship to one of the most dangerous convulsive disorders, namely laryngismus stridulus, a neurosis limited almost entirely to those suffering from rickets. It has been demonstrated that laryngismus stridulus occurs in rachitic subjects when craniotabes is absent, so cranial softening is not indispensable to the production of this complication.

Well-marked changes are also observed in other bones. The ribs become affected early, and are greatly implicated. One of the earliest and most characteristic symptom of rickets is the "rachitic rosary" or beading of the ribs, the result of the proliferating changes which take place at the costo-chondral articulations. The joints swell in all directions, the nodular projection being as distinct on the under as on the subcutaneous surface. The ribs are also often thickened at a spot between the tubercles and the angles where spontaneous fracture occasionally occurs. Owing to softening of the ribs a peculiar deformity of the thorax is often observed; there is an abrupt bending of the ribs near their junction with the cartilages, produced by atmospheric pressure during respiration; this leads to the formation of a groove on the antero-lateral aspect of the chest, extending from about the third rib downwards and slightly outwards. The transverse diameter of the

¹ *Loc. cit.*

anterior half of the chest is therefore materially lessened ; this diminishes the lateral expansion of the lung in inspiration, and causes unusual prominence of the sternum, hence the expression "pigeon breasted."

The clavicles are either bent abruptly forwards or two curvatures may exist, one backward near the outer extremity, and a second larger, near the sternum, looking forwards and slightly upwards.

The scapulæ are thickened at their margins.

In the pelvis are observed characteristic deformities, which in the female often have far-reaching consequences. The brim is widened by the pressure of the abdominal organs from above, the antero-posterior diameter is diminished through the sacral prominence being pushed forwards by the pressure of the spinal column supporting the weight of the head and upper part of the body, while pressure from below, through the heads of the thigh bones and the ischial tuberosities, tends to narrow the pelvic outlet. The effects of these changes on the female pelvis, and the resulting difficulties likely to arise in case pregnancy occurs, are too obvious to require more than a passing reference.

There is a retardation in the growth of the facial bones, shortening of the lower jaw from a change in the direction of the alveolar margin, inclination inwards, together with an alteration in the shape of the bone.

The vertebræ are in most cases only very slightly implicated; occasionally they are softer, more yielding, and their cancelli are filled with a reddish, pulpy substance. The spinal curvatures observed in rickets are to be mainly attributed to the loose state of the ligaments. They are chiefly backward, with occasional slight lateral deviations. The posterior curve occupies the dorsal region and constitutes a segment of a large circle, differing in this respect from Pott's curvature, which as a rule involves at the most two or three vertebræ. Another point of distinction between these two forms of curvatures will be found in the age at which they occur; Pott's disease being rare

under the age of two years. While on duty at the Children's Dispensary, I have on more than one occasion seen children of fifteen months of age, suffering from rachitic curvature, brought carefully encased in a Sayre's jacket. It should also be observed that a rachitic spinal curvature readily disappears when the child is placed in a recumbent position, at least this is true of the earlier stages of the affection; later, from changes in the vertebræ and their cartilages, the deformity may be more obstinate and more difficult to correct.

In the third period, or that of bone condensation, lime salts are deposited in the deformed bones and in excess on the concave surfaces, where the exudation has been abundant and where the capillaries have not been subjected to any pressure. The rachitic bone is, therefore, thicker and denser on the concave side, and thinnest on the convex aspect where the periosteum is more tense and its capillaries more or less compressed.

Symptoms.—Rickets is easy of diagnosis, when the affection is fully established. No one could very well misinterpret the curved bones and tumid joint ends, but the disease in its earlier manifestations is often overlooked.

There are two periods at which rickets may show itself: in the first, the child manifests symptoms of the disease after the fourteenth or fifteenth month; up to this time it may have passed in a regular manner through the various normal developmental stages. The usual teeth may have been cut, the anterior fontanelle is about to close, and the child has commenced to walk in due time and without difficulty. In such cases the early symptoms of rickets are always obscure for a time, and may remain doubtful for some considerable period. The child becomes peevish; loses its liveliness, its freshness, and its accustomed activity of movements or perhaps the power of walking altogether. The appetite becomes precarious, the abdomen prominent, and the alvine evacuations

unhealthy. Sleep is disturbed and the child tosses off the bed-clothes, and perspires freely about the head and neck. Should these symptoms be combined with looseness of the joints, especially the ankles, and a general flabbiness of the thigh and leg-muscles, we may venture on a diagnosis of rickets before any rachitic alterations of the bones and joints are observable.

Usually rickets develops before the fifteenth month; in this instance the disease is generally characterised by signs indicating delay and irregularity in the developmental process, in addition to the symptoms just mentioned. A normal infant cuts its first teeth at or about the age of seven months, begins to walk at thirteen, and has its anterior fontanelle closed before the eighteenth month. Any considerable departure from this rule will most usually indicate a rachitic disposition. Retarded dentition is a common symptom, and Jenner considers the non-appearance of a tooth by the ninth month, with few exceptions, as a sign of rickets; the peculiar angular shape of the head, with a widely open anterior fontanelle and very decided weakness of the legs, should cause us to suspect the presence of rickets. Merei¹ gives it as his experience that weakness of the legs is a symptom never absent in any case of rachitism, whether the disease commences in early infancy or after the appearance of the first groups of teeth, after the ossification of the fontanelle is accomplished and the faculty of locomotion freely acquired. Accompanying this weakness of the legs will be found flabbiness of the muscles of the thighs and legs, and a certain looseness of the ankle-joint. Of all the symptoms of rickets the most characteristic and the one which may be regarded as diagnostic of the disease, is chronic enlargement of the ankle and wrist joints, the so-called "double-jointed" appearance constantly alluded to by the mothers.

¹ *Loc. cit.*, p. 194.

Children attacked with rickets are peculiarly liable to chest affections, especially bronchitis and broncho-pneumonia, which are not uncommon causes of death in such cases. They also frequently suffer from disordered digestion, with diarrhoea and offensive evacuations. Laryngeal spasm (crowing disease) Merei most frequently found in children who had large flat and angular heads, with the fontanelle widely open, and generally between the eighth and eighteenth month, namely during the process of dentition. Laryngeal spasms are peculiarly obstinate in rachitic infants and liable to pass into fits.

Prognosis.—As a general rule rickets cannot be considered a fatal disease. When death does take place it is usually from one of the complications, especially chest affections, which are so frequently witnessed, and assume a much graver aspect whenever the chest is deformed and contracted. The lung space is seriously encroached upon, and a very moderate catarrhal attack may prevent proper aëration of the blood, speedily leading to the production of serious symptoms and often a fatal issue. The gravity of these inflammations of the respiratory apparatus is usually proportionate to the degree of recession of the ribs during inspiration.

It may be taken as a general conclusion that the older the child is when rickets develops the milder the disease, the quicker the recovery, and the less the deformity. The severest cases are certainly those in which the disease commences before the child is a year old. In a very large proportion of those who have suffered from rickets, all traces of the deformities subsequently disappear; a few permanently retain evidences of the affection, but excepting a certain diminution in height they are strong and well. The rachitic female possesses peculiarities and risks arising from ill-formed and stunted pelvic bones which may seriously interfere with parturition.

Treatment.—The suitable remedies for preventing and curing rickets are easily deduced from what has gone before. We must adopt means likely to re-establish healthy nutrition and

to restore the normal developmental processes. For this purpose hygienic as well as therapeutic measures are requisite. Among the former, pure air, suitable diet, and attention to cleanliness claim a foremost position. A rachitic child should have, if possible, a large and well-ventilated bedroom, not over filled with beds for other children or grown persons, and should be kept during the day in a room having similar advantages.

Infantile diet merits careful consideration. There can be no doubt the child's natural and proper diet until it is about ten months old is its mother's milk, failing this the best substitute is a wet-nurse, judiciously selected. In case breast-milk is not available, cow's milk with proper dilution and addition of milk sugar should be employed, combined after the age of six months with small but gradually increasing quantities of farinaceous food. Bathing and sponging, Merei considered as not only prophylactic, but also curative of rickets in its slighter degree. The promotion of a healthy action of the skin, by warm baths, after the ninth or twelfth month, once or twice during the week, and cold sponging every morning, will contribute efficaciously to prevent the development of rickets. The tepid salt bath will usually prove to have an invigorating effect, but in cases of muscular flabbiness and spinal weakness it often produces languor, and cold sponging, together with systematic friction with a rough towel, may be substituted for it with advantage. The only internal remedies beneficial in rickets are cod liver oil, iron, and quinine. Lately phosphorus has been added to the list, contradictory reports as to its efficiency have, however, been published. Of the almost specific action of cod liver oil we have abundant proof, Trousseau declares it to be the most important remedy in this disease, and one which is almost infallible in its curative effects. There is, however, one reservation, which should always be made, the efficacy of the drug will in all cases depend upon the patient's ability to take and digest it well. There may be a repugnance to it, or its exhibition may produce diarrhœa. The admixture of cod

liver oil with maltine¹ (one part to three) makes a much more palatable medicine, and children will as a rule take this when their aversion to the oil is decided and almost insurmountable. The oil may also be combined with lime water and lacto-phosphate of lime. The indication for iron in various combinations, such as Parrish's food, vinum ferri, citrate of iron and quinine, and the saccharo-carbonate, is the anæmic state so frequently witnessed in rachitic children. The first and perhaps the most certain sign of the beneficial effects of any remedy is the increased appetite for food. It occurs not unfrequently that after a week or two of careful treatment a rachitic child, who previously was urged in vain or even to its detriment to take animal substances, begins to take and support them well.

RACHITIC DEFORMITIES AND THE OPERATIONS FOR THEIR CORRECTION.

The chief of these and those which often demand operative interference are found in the lower limbs. They are bow-leg,

FIG. 39. ✓

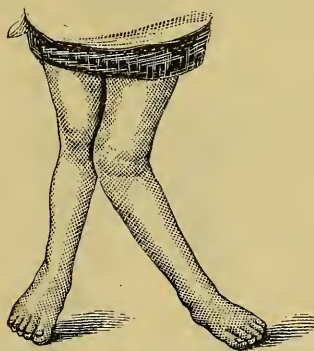


FIG. 39.—Left genu valgum, child, three years.

knock-knee—genu valgum, or in-knee (*figs.* 39, 40, and 41), and genu varum or genu extrorsum (*fig.* 42). These deformities

¹ It is absolutely necessary that a true form of maltine should be used; this caution is required as many spurious forms are dispensed.

FIG. 40. ✓



FIG. 40.—Genu valgum, male, aged thirty. Evidences of early rickets.

FIG. 41. ✓

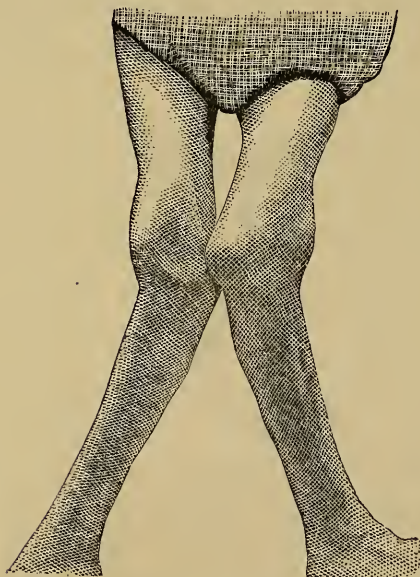


FIG. 41.—Genua valga, male, aged twenty-six. Very marked hypertrophy of internal condyles.

may be variously combined. Bow-leg in its slighter degree is very often seen, even in children who manifest none of the symptoms usually associated with rickets, and disappears without special treatment. In its most marked forms it constitutes a common rickety deformity. It may affect one leg only, or both limbs may be curved outwards. When combined with a similar curvature of the femur it produces the out-knee, or genu extrorsum. Another variety is also observed, where an in-knee on one side fits into the concavity of a genu

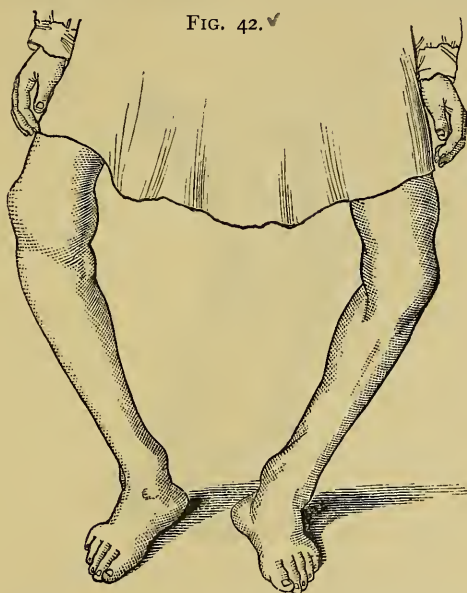


FIG. 42.—Double genu varum, remedied by osteotomy of the tibiæ.

extrorsum on the other (*fig. 43*). Slight bowing outwards of the legs in rachitic infants will disappear without bandages or mechanical appliances of any kind and by proper constitutional treatment alone. The embarrassment of such children with heavy steel apparatuses cannot be too much condemned. Owing to muscular weakness they are unable to carry their own weight, and yet how often we see them saddled with the

so-called mechanical supports. I have often observed the greatest benefit derived from throwing these away, and substituting some light splints for them.

The treatment of these deformities consists in the observance of all the rules—dietetic and hygienic—necessary to combat the constitutional affection. The child should be forbidden to walk, and any difficulty in carrying out this instruction will best be met by applying splints which extend beyond the feet. Systematic frictions, night and morning, of the affected limb will prove very beneficial. I am in the habit of advising

FIG. 43. ♀



FIG. 43.—Left genu valgum; right genu varum.

the use of salt in the water, or, wherever procurable, of sea water for the bath, and of instructing the nurse to rub the legs with a rough towel, the friction being made principally in the upward direction. The ankle and knee joints require attention at the same time in order to strengthen their relaxed ligaments. When the bowing affects one leg only, a light, well-padded splint, reaching from the knee to a short distance beyond the foot, is to be applied on the outside of the limb, and kept in position by a suitable calico bandage. Occasionally for this

purpose a Martin's elastic bandage has been employed, but unless the greatest care is observed in its application troublesome sloughing will result. If both limbs are bandy, the splint padded on both sides is to be placed between the legs and secured to them. This treatment must be persevered with for a considerable time, and if no improvement is observable the question of osteotomy is to be entertained. As a rule this operation will rarely be necessary under three years of age. In those cases frequently met with, where the curve is in the lower third of the leg and the bone is still soft, the limb may be forcibly straightened with or without fracture while the child is under the influence of an anæsthetic. The chief objection to fracturing the limb is that the bone rarely gives way at the desired spot, for this reason osteotomy is to be preferred. The operation is of the simplest kind. A tenotomy knife is introduced and passed across the anterior surface of the tibia, where the concavity of the bend is most marked, and the periosteum divided. A fine watch-spring saw is passed in through the same opening, and the tibia divided about three parts through. The saw is withdrawn and the limb straightened by breaking the remaining bridge of bone. An osteotome may be used for the same purpose, as recommended by Dr. Macewen. I adhere to the saw in all osteotomies, and so far I have never had any reason to regret my choice. With an experience of something like three hundred osteotomies without any mishap, I shall be slow to adopt any other instrument.

The whole operation is conducted under the spray and a wood-wool dressing is applied after the deformity has been corrected; the limb may be encased at once in Croft's splint (plaster of Paris), or a wooden splint is adjusted to the limb for a week or so and then the plaster apparatus employed. In severe cases of bow-legs several osteotomies (sometimes a dozen) have been made before the deformity could be satisfactorily corrected; in these the femur as well as the tibia and fibula have required division. Usually the fibula yields sufficiently or can be frac-

tured; sometimes, however, it also needs dividing. The most difficult deformities to correct are those in which the tibia is curved forwards or forwards and outwards. In some cases the curve implicates the entire bone, while in others the lower third or more frequently the lower two-thirds are involved. The tibia is not only curved forwards, but is also often flattened laterally, and in this deformity the fibula shares. When slight the anterior curve may be corrected by simple division of the tibia at the most prominent part of the convexity, but when very marked several osteotomies will be requisite, or perhaps the removal of a wedge with its base anterior would prove of greater benefit.

Dr. Macewen¹ gives the following rule for ascertaining the size of the wedge to be removed. Turn the limb on its side and take a tracing of the anterior border of the tibia. Next measure the breadth of the tibia from before backward, at the most prominent part of the convexity, and draw a second line parallel to the former corresponding to the breadth measured, then cut the shape out. After this has been done, fold the paper at the most prominent part of the convexity, wedge fashion, with its base anteriorly, until the pattern has become straight. The base of the wedge will then represent the size of the cuneiform portion to be removed. The stages of the operation he describes in the following terms. Having ascertained the size of the wedge, it is convenient to have it marked by measuring it by a pair of calipers, keeping their blades fixed at the distance measured so that they may be applied to the bone when necessary. An incision sufficient to admit the instrument and if necessary the finger is used. A chisel (not an osteotome) is employed. It ought to have a clean cutting edge with little bevel. It is convenient first to remove a wedge smaller than that required, and then to remove from either side one or two shavings up to the desired extent. In cutting

¹ *Osteotomy*, London, 1880, p. 154.

out the wedge the periosteum on either side can be preserved. After removing the wedge and any fragments of bone, the fibula is to be attended to. In many cases a simple fracture may be made, but in some, especially when flattened and elastic, this is not so easy, and it is better to perform a subcutaneous osteotomy. Should the tendo-Achillis offer an obstacle to the complete straightening of the limb, it must be divided. Macewen in the majority of his cases did not find it essential to divide the tendon.

A word of caution is essential, it is to see that no muscular fibres are caught between the tibial fragments; this might lead to an undesirable result. After the operation the limb is placed on a back splint and supported by two side splints, very much after the manner employed in the treatment of ordinary fractures. When absolute cleanliness has been duly observed during the operation, the wound generally heals without suppuration, and the procedure may be regarded as comparatively simple, the risks being very little more than those attending an ordinary osteotomy.

Genu valgum—knock-knee or in-knee,—a common deformity respecting the formation of which various theories have been advanced. It is observed in infants attacked with more or less pronounced rickets, and in them it usually co-exists with a valgus like relaxation of the ankle and plantar surface, a possible determining cause. Besides occurring between one and five years, it is met with from thirteen to sixteen, but only, I believe, in those who bear evidences of rickets in early life. Some have attributed it to the contraction of certain muscles, biceps femoris, Duchenne; others, Guerin, Billroth, to a fibrous retraction of the external lateral ligament, together with shortening of the biceps and fascia lata, mistaking the effect for the cause. Malgaigne, Stromeyer, and other surgeons think knock-knee arises from relaxation of the internal lateral ligaments, followed by an outward inclination of the leg and hyper-

trophy of the internal condyle. Mikulicz,¹ on the contrary, has conclusively demonstrated by the comparative study of the bones of healthy limbs and those of genu valgum, and by a series of longitudinal sections of these same bones, that genu valgum is a deviation which has its seat in the extremities of the diaphyses of the femur and tibia, and which is due in part to an unequal growth of the diaphysis at its epiphysary limit, and partly to an abnormal curvature of the entire diaphysary extremity; the epiphyses themselves are not concerned. The fibula does not participate in the deviation, but in extreme cases it presents an arrest of development. In the macroscopic and microscopic study of sections mentioned above, Mikulicz always found rachitic enlargement of the epiphysary cartilages. Analogous changes in all parts of the skeleton corroborated the rachitic origin of these deformities, notwithstanding the adult age of the patients. Upon the living it is rare not to find symptoms which indicate a rickety affection of the bones. As in rachitic infants we discover swellings at the junction of epiphyses above the articulations of the wrist and ankle, and especially at the anterior extremity of the ribs (rachitic beads). Dr. Macewen,² from personal investigations into the pathology of knock-knee, concluded "that the affection could not be accounted for by a single factor; that the cases differed very greatly. The most constant factor was an inward curve of the lower third of the femur, which lowered the level of the internal and raises that of the external condyle. The second factor was an abnormal elongation of the internal condyle, which is frequently found and generally associated with the inward curve of the lower third of the femur. These separately or combined form the chief pathological and anatomical features in knock-knee. There is another element found in about one-third of the whole number of cases, consisting of an increase of osseous matter on the inner side of the tibial diaphysis at

¹ See *Revue de Chir.*, June, 1883.

² *Osteotomy*, London, 1880, pp. 40 and 49.

its proximal extremity, which causes the head to sit askew on the shaft;" usually this tibial deformity is slight, sometimes it produces a distinct appearance.

Owen¹ offers still another explanation. Genu valgum, he observes, "is generally associated with, if not determined by, a relaxation of the ligaments of the ankle and sole of the foot. The tibia having lost much of its support at the inner ankle, the upper surface of its head receives the weight unevenly from the two femoral condyles, the outer tuberosity getting more than its due share. This extra pressure causes some arrest of growth of the external condyle of the femur, whilst under the diminished pressure the internal condyle grows inordinately; in some instances it is at the internal tuberosity of the tibia that the growth of bone takes place, in which case there will be considerable bony thickening at the inner side of the epiphysial cartilage.

Operations for Genu Valgum.—When the deformity is slight and of recent date, some good may result from the application of a straight outside splint, combined with daily manipulations of the limb, and the administration of such internal remedies as are appropriate for the rachitic condition. Another plan of treatment found efficacious is to place a thin pillow between the knees at nights, and at the same time to tie the ankles together. If these means are inadequate, as they very often are, the patient may be anæsthetised, and the limb forcibly straightened by the operator placing his knee against that of the patient, and bringing the deformed limb into position. With this may be combined tenotomy of the biceps tendon and of the ilio-tibial band. This procedure, formerly extensively practised by Delore, of Lyons, is clumsy and untrustworthy; and the forcible separation of epiphyses, *décollement des épiphyses*, may produce unsatisfactory results, if not something infinitely worse; this subject will be referred to at greater length later (see osteoclasia).

¹ Heath's *Practical Surgery*, Art., Genu Valgum, by Mr. Edmund Owen.

Two classes of osteotomies are advocated for the correction of genu valgum: 1. Those which attack the internal condyle itself and aim at its partial (Chiene) or complete removal (Annandale) or merely at its separation (Ogston, Reeves). 2. That in which the condyloid extremity of the femur is divided (Macewen).

Some earlier operations than any of these were performed on the continent. Mayer,¹ of Würzburg, in 1851, removed a wedge of bone from the upper part of the tibia in a case of knock-knee, afterwards bringing the osseous surfaces into close apposition. Subsequently the opposite limb was operated on in the same manner, the wounds healed by first intention, and three months afterwards the boy (aged fifteen years) walked with a firm and natural gait. The severity of the operation, however, prevented its adoption. Billroth² divided the tibia in a case of genu valgum, and Schede³ (Berlin) removed a wedge of the tibia and then divided the fibula.

Annandale⁴ made an incision five inches in length along the inner aspect of the knee joint, opened the articulation, and cut across the internal lateral ligament. The patella with its ligament was drawn outwards, and the crucial and external lateral ligaments were divided; an oblique slice was now sawn off from the condyles of the femur, the tibia not being interfered with. After the removal of the slice of bone, the limb was readily brought into a straight line with the thigh, and a drainage tube being inserted into the cavity of the joint, a few sutures were applied, and the limb placed on a wire splint in a straight position. The operation was carried out with all anti-septic precautions. Some suppuration followed operation. In seven weeks patient was allowed to get out of bed. The joint was supported by lateral splints, which were removed daily to permit of passive movements of joint being made. Three weeks later patient was allowed to bear weight on limb.

¹ *Lancet*, 1853, p. 557.

² *Archiv für klin. Chirurg.*, 1875.

³ *Berliner klinische Wochenschrift*, No. 52, 1876.

⁴ *Edin. Med. Journal*, July, 1875.

Ogston's¹ operation was performed in the following manner: Knee flexed as far as possible and the thigh turned outwards. A long and strong tenotomy knife (Adams') was introduced through the skin, three and a half inches above the tip of the internal condyle, on the inner side of thigh, and so far back as to be opposite the ridge of bone running between the linea aspera and the condyle. Its blade was carried forwards, downwards, and outwards over the front of the femur, with its cutting edge directed to the bone. When its point could be felt under the skin in the groove between the condyles, where the patella would normally have been lying in the flexed position of the limb, the cutting edge was pressed against the bone, and the soft parts and periosteum divided by one slow, firm movement in withdrawing the knife. The external wound thus made was about one-third of an inch long, and forms the entrance to a subcutaneous tunnel, running over the front of the femur and ending in the cavity of the joint. Adams' saw for subcutaneous division of the neck of the femur was introduced into the tunnel, and the condyle sawn off by directing the edge of the saw backwards. The position of the saw could be exactly controlled by feeling its point working gradually backwards in the groove between the condyles. As soon as it was estimated that the condyle was almost entirely separated and that the saw had arrived near the popliteal space, it was withdrawn. The knee was completely extended, and then with the hands, and the operator's knee as a fulcrum, the patient's limb was forcibly straightened by bending the leg inwards. The limb instantly became as straight as a healthy limb, and could even be put into a somewhat bandy position. Lister's antiseptic precautions were observed throughout. The limb was afterwards bandaged to a long Liston's splint, the thigh and leg being kept in line by pads. Passive motion sixteen days afterwards; movements continued for a month.

¹ *Edin. Med. Journal*, March, 1877.

Schmitz¹ modified Ogston's operation by making a larger wound, which enables the operator to see what is being done. He reports a good result in a girl sixteen years of age. Another modification of Ogston's procedure was proposed by Mr. Reeves² in 1878. He separated the internal condyle with a chisel instead of a saw, and carried the separation as far as the cartilage covering the condyle, but without opening the joint. The difficulty of accomplishing this and straightening the limb without laying open the joint has been shown by Dr. De Santi.³

Professor Chiene⁴ removed a wedge from the internal condyle. The directions for performing his operation are as follows: "Find tubercle on internal condyle, to which tendon of adductor magnus is attached; an incision two to three inches in length is made over the tubercle in the long axis of the limb. The incision commences half an inch below tubercle and is carried upwards a sufficient distance. After division of skin and fascia tendon of adductor is exposed. Pass in front of this tendon between it and fibres of vastus internus. Bone covered by periosteum is exposed, and superior internal articular artery is seen, and divided after passing a double ligature below it and tying the vessel. Periosteum is then divided crucially and turned aside, exposing bone. With chisel and mallet a wedge-shaped portion of bone is removed from the base of the condyle immediately above tubercle of attachment of adductor magnus. Breadth of wedge will depend on amount of deformity. Long axis of wedge runs downwards and outwards towards notch between condyles. The wedge is at a higher level than epiphysial line, its apex may touch the line. After sufficient amount of bone is removed, the tibia is grasped at its lower extremity, and, by pressure inwards, neck of bone attaching the condyle to the femur is bent and the limb straightened."

¹ *Centralblatt f. Chirurgie*, April, 1879.

² *British Medical Journal*, Sept. 21st, 1878.

³ *Archiv. Gén. de Méd.*, June, 1879.

⁴ *Edin. Med. Journal*, April, 1879.

All these proceedings have been practically abandoned in favour of Dr. Macewen's supra-condyloid operation, published in the first instance in the *Lancet*,¹ afterwards in his work on osteotomy.² The limb being rendered bloodless is placed on a sand pillow, where it is securely held by two assistants. The operator sponges the seat of operation with 1—20 carbolised watery solution; the spray is then directed on the part. A sharp-pointed scalpel is introduced on the inside of the thigh at a point where the two following lines meet—one drawn transversely a finger-breadth above the superior tip of the external condyle, and a longitudinal one drawn half an inch in front of the adductor magnus tendon. The scalpel here penetrates at once to the bone, and a longitudinal incision is made sufficient to admit the largest osteotome and the finger should the surgeon deem it necessary. Before withdrawing the scalpel the largest osteotome is slipped by its side until it reaches the bone. The scalpel is withdrawn, and the osteotome, which was introduced longitudinally, is now turned transversely in the direction required for the osseous incision. It is convenient to pass the edge of the osteotome over the bone until it reaches the posterior internal border, when the entire cutting edge of the osteotome is applied, and the instrument is made to penetrate from behind forwards and towards the outer side. After completing the incision in that direction, the osteotome is made to traverse the inner side of the bone, cutting it as it proceeds, until it has divided the uppermost of the internal border, when it is directed from before backward towards the outer posterior angle of the femur. After the inner portion of the bone is divided, a finer instrument may be slipped over the first, which is then withdrawn; and even a third, if necessary, may take the place of the second when the outer portion of the bone comes to be divided.

¹ *Lancet*, March 30th, 1878.

² See also Heath's *Practical Surgery*, Art, Osteotomy, by Dr. Macewen, from which the above description is obtained.

When the operator thinks that the bone has been sufficiently divided, the osteotome is laid aside, and a sponge saturated in 1—40 carbolised watery solution is placed over the wound. While the surgeon holds the sponge he, at the same time, employs that hand as a fulcrum ; with the other he grasps the limb lower down, using it as a lever, and jerks, when the bone will snap or bend ; the limb is then brought into a straight line and the wound covered with a sponge saturated in 1—40 watery solution, kept in position by a gauze bandage, and the elastic webbing controlling the circulation removed. A similar operation is now practised on the opposite limb. They are then dressed antiseptically and placed in a special splint, which is a modification of the half box, the outer portion being carried up like a long splint to about the level of the third or fourth rib, and projecting beyond the posterior splint at the foot. This projection is fixed in the clamp of a bed-rest, and so the whole limb and splint are kept motionless and steady.

That the popliteal artery is in some danger of being wounded in supra-condyloid osteotomy is proved by two cases,¹ where the accident has actually occurred. In one, on the anterior aspect of the popliteal artery, there was a small opening corresponding to a sharp spicule of bone, which projected from the upper end of lower fragment of femur. There was no bleeding at the time of operation, but in the evening of the same day the dressings had to be renewed on account of the blood having oozed through them. Fifteen days later the popliteal artery was exposed, and a ligature placed above and below the puncture, and the vessel divided between. On the following day amputation of the thigh became necessary in consequence of gangrene of the leg. The patient died the same day.

In the second case a gush of blood followed the second withdrawal of the chisel ; a pad of salicylic silk was placed over

¹ *Lancet*, vol. i., 1884, p. 564 ; also p. 891.

the wound. After an interval of three hours, during which the child (aged seven years) did not rally, blood began to ooze through the dressings. The foot at the same time was cold and blue, and no pulse could be detected in either of the tibial arteries. The splint was removed, there was free hæmorrhage, and the popliteal space and neighbourhood of knee joint distended with blood. Mc.Gill now determined to tie the popliteal artery, and did so from behind. The vessel was found completely and transversely divided. The after progress of the case was satisfactory. No recurrence of the bleeding; the wound healing by granulation. The treatment carried out by Mr. Mc.Gill would be the proper procedure to adopt in case the popliteal was accidentally injured in osteotomy of the femur.

Instead of the chisel, Adams' saw is often employed in the transverse division of the femur above the condyles, and the operation may be conducted from the outer side. I have never used the chisel in any osteotomy, being thoroughly satisfied with the performances of the saw: the objection usually urged against it, that the bone dust causes suppuration, being, as far as my experience goes, purely imaginary.

Barwell¹ performs a triple osteotomy for knock-knee. The femur is first attacked a little above the epiphysial junction. Division of the external two-thirds of the bone being effected with a chisel, the limb is straightened, and the gap thus left is allowed to fill up and consolidate. When this is accomplished, the second step of the operation is performed: transverse division of the tibia, about an inch below the joint, an oblique division of the fibula is made, and the limb then brought into a straight line.

Experience has demonstrated that a triple osteotomy is not requisite for straightening a limb the seat of genu valgum, femoral division with tenotomy of the biceps being quite sufficient for the purpose.

¹ *British Med. Journal*, May 25th, 1878, p. 748.

Osteoclasia, or Osteoclasia, including Redressement Forcé.—Another method employed for straightening deformed limbs is that known as osteoclasia, which signifies and essentially consists, in deliberately breaking a bone. It differs from osteotomy in accomplishing its object without any cutting operation.

At first and long years ago intentional division of a bone was made use of to correct misshapen callus. In 1699, La Motte fractured a badly-united femur, at the end of nine weeks, in a young man sixteen years of age. The operation was conducted by extension made by assistants, while the surgeon manipulated the seat of fracture. The patient was cured in four weeks. This case created some considerable sensation, and soon special instruments were constructed for the purpose of rupturing the deformed callus.

Jules Guérin, in 1843, reported a number of cases of subcutaneous fracture, with immediate correction of rachitic curvatures, and proposed to introduce this practice under certain conditions as the usual mode of treatment. The plan was also adopted, both in France and Germany, in the treatment of coxo-femoral ankylosis. It is, however, in the straightening of genu valgum that the method has gained some considerable notoriety. Practised for many years by Delore, of Lyons, it spread through a communication which he made to the *Congres de l'Association française pour l'avancement des Sciences*, held in Lyons in 1873. Tillaux introduced it into Paris, and completely modified the proceeding which Delore had employed. Then appeared a number of theses (Saurel, 1872; Barbarin, 1873; Barbier, 1873; Vergne, 1875; De Santi, 1876; Peyre, 1879) giving clinical and experimental researches into the effects of *redressement forcé* or *redressement brusque*. Collin at the same time constructed an osteoclast, based on scientific principles.

Then appeared in England the various osteotomies already described, the results of which threatened to eclipse the per-

formances of the osteoclast. Robin¹ advocated osteoclasia by a new and improved proceeding, and since then the operation has again advanced in favour among the French surgeons, and now it is more extensively practised than ever.

Whatever mode of performing osteoclasia is adopted, whether by the hand, *ostéoclasie manuelle*, or by some mechanical appliance, *ostéoclasie instrumentale*, the principles upon which the operation is based are reduced to four—vertical pressure, flexion, traction and torsion; sometimes one proceeding is utilised, sometimes a combination of several.

Delore's proceeding *redressement forcé* for the correction of a genu valgum is described in the following terms:—The patient, being anæsthetised, is brought to the edge of a couch. Underneath the external malleolus a pillow is placed, which an assistant holds firmly. The knee is thus raised above the plane of the couch, and its inner projecting surface looks upward. Upon this the surgeon presses with his hands, through which is transmitted the weight of his body, at the same time giving slight jerks. It is not necessary to employ very great force. He proceeds slowly and deliberately, and after a variable time, according to the age of the patient, the straightening takes place. The time will vary from five minutes to half an hour. In the child with rachitis still in progress very moderate force is necessary; in individuals of eighteen or twenty very great force will be requisite. During the operation it is not uncommon to hear cracks more or less distinct, immediately followed by straightening.

In the flexion method the surgeon seizes the limb on each side of the curvature, and then produces a fracture either by increasing the curve or the contrary. This plan succeeds very well, as I can testify, in rachitic curves of the legs. Tillaux employs a different plan. The patient, anæsthetised as before, reclines on a couch, with the inner surface of the knee resting

¹ Thèse de Lyon, 1882.

on the edge; the fulcrum should be the internal condyle of the femur; the rest of the limb hangs over the end of the couch. A strong assistant steadies the thigh in this position; then the surgeon seizes the leg about the centre, and, using it as a lever, exercises pressure downwards until he hears a distinctive crack. The limb is immediately placed in a silicate apparatus, with lateral supports, and is kept there for sixty days.

To replace the hands of the operator various mechanical appliances have been designed; some of them are exceedingly ingenious, and fulfil their purpose in a very effective manner. The most recent and perhaps on the whole the most efficacious is the one invented by Robin¹ in 1881. The great advantage of this apparatus over all others is the accuracy with which the seat of fracture can be determined, which will depend on the position of the fulcrum. We can thus accomplish one of the fundamental requirements of scientific osteoclasis, namely the possibility of producing a fracture at the exact spot desired. The after treatment, although very simple, should be conducted with care, as it is of great importance. The rectified limb should be placed at once in an immovable apparatus, but only in such as can be easily removed, so that we may observe any symptoms that may arise. Croft's plaster apparatus will answer every purpose. Robin allowed six to eight days to elapse before rectifying the position of a limb subjected to osteoclasis. After the plaster bandage has been removed, massage, baths, douches should be prescribed, as these constitute the best means of restoring the mobility of the joint and the strength of the muscles. Among the occasional results produced by osteoclasis are hyarthrosis, arthritis, relaxation of the ligaments, also very severe pain in the knee lasting twenty-four or forty-eight hours (Lannelongue).

Osteoclasis in Rickety Curvature of the Legs.—The credit of introducing the procedure for this purpose belongs un-

¹ Thèse de Lyon, 1882.

deniably to Guérin, who first practised it on the right leg of a rachitic child, two and a quarter years old. The operation did not gain the general approval of the French surgeons, for in 1874 we find Tripier¹ disapproving of it, because of its dangers and difficulties, and the impossibility of determining the exact spot where the fracture would take place. Introduced into Germany it met with more favour, for it had the approval of Volkmann and Billroth. It also had some partisans in Italy, America, and England.

It is important to determine at what period in the evolution of rickets *redressement forcé* should be employed. During the first two periods (stages of softening and deformity) general treatment, with efficient appliances, will prevent or correct curvatures of the bones. It is necessary that the disease should have entered the third period—that of condensation or eburnation—before osteoclasia is justifiable. The surgeon should avoid premature intervention; on the other hand, he must not wait until the structure and resistance of the bone is such as to render the application of osteoclasia impossible. He should interfere when the digestive functions are re-established, the apathy has disappeared, and the child's cheerfulness indicates the period of repair (Aysagner²). If the rickety curvatures are old, or if the work of repair (eburnation) has proceeded rapidly, osteoclasia becomes impracticable and osteotomy will be necessary.

Osteoclasia for the Rectification of Knock-knee.—As mentioned above, Delore was the first to extend this method to the treatment of lateral deviations of the knee. The principal thing aimed at was separation of the lower epiphysis of the femur; but no doubt the lesions produced by *redressement forcé* were complex and unexpected. The fear has been expressed by Verneuil and Lannelongue that the injury to the femoral epiphysis might interfere with the growth of the limb in length. Theo-

¹ *Dict. Encyc.*, Art., Rachitisme.

² Thèse de Paris, 1879.

retically, no doubt, this is true; but, as far as I know, no observations of this nature have been made, and it has not been witnessed in cases seen some months after operation. Laceration of the ligaments might very possibly lead to relaxation with lateral displacement of the articular surfaces or to repeated attacks of arthritis. As in the adult manual osteoclasis often failed, it was found requisite to substitute some mechanical appliance for the hands of the surgeons. Collin's instrument had one serious drawback, it acted on the bones through the medium of the ligaments. Robin overcame this difficulty in his machine by operating exclusively on the femur, the joint being left altogether outside the area of operation. It is claimed for osteoclasis that the duration of treatment is less than after osteotomy, the patients walking after periods varying from thirty to sixty-six days. In osteotomy, on the other hand, ten weeks are necessary from the date of operation before the patient walks freely (Macewen). I have been induced to present a resumé of what is known respecting osteoclasis, owing to its being so favourably regarded by many of our French confrères; still it is difficult to see how this proceeding ever hopes to supersede osteotomy, which is simple, requires no complicated instruments, is free from danger, and yields such excellent results.

ACUTE RICKETS, OR INFANTILE SCURVY.

Under this term Dr. Barlow¹ has described a condition which has previously been referred to as hæmorrhagic periostitis,² scurvy supervening on rickets,³ and as osteal or periosteal cachexia.⁴ A typical example of the disease, which occurred under Dr. Barlow's care, is thus reported.

The boy, aged fifteen months, was of a pale sallow com-

¹ *Med. Chir. Trans.*, vol. lxvi., 1883.

² T. Smith, *Pathol. Trans.*, London, vol. xxvii., 1876.

³ Dr. Cheadle, *Lancet*, 1878, p. 685.

⁴ Dr. Gee, *St. Bartholomew's Hospital Reports*, 1881, vol. xvii.

plexion, fat but flabby. His rectal temperature was 101° ; there was no nervous nor visceral disease, except that the liver was larger than normal. He was continually moaning, and screamed violently when approached and touched. The dominant symptoms were in the limbs; the right wrist was dropped and the left thigh continually drawn up; the ribs were beaded, but there was no grooving of the thorax; the left thigh and leg were tightly swollen, assuming a cylindrical shape; the epiphyses of the knees were enlarged and there was a tendency to knock-knee. There was profuse sweating about the head. The boy was a first child, born slightly before term, and seemed vigorous for the first six weeks, during which time he had his mother's milk; but since its failing he had been deprived of fresh food, his diet consisting of the various infant foods of Nestlé, Robb, &c. The child sat up well, and stood with assistance at thirteen months old; but five weeks before he came under observation he ceased to do either, the left leg and ankle being swollen, and the child shrieking if approached. He was taken to a bone setter, who said that one of the bones of the spine was out, and a presumed operation to set it right was performed; but as no explanation was given of the swollen wrist, dropped right hand, and condition of left thigh, further opinion was taken. The child was obviously the subject of moderate rickets; and the opinion was formed that under the periosteum of the left femur and tibia there was an effusion of blood, and that the extreme tenseness of the limb was due to blood-extravasation in the deeper muscular layers, with the serum filtered out into the more superficial parts of the limb; and the view was held that the boy was suffering from the supervention of scurvy on rickets, though with no sponginess of the gums. The treatment suggested was to surround the whole of the left lower limb and the right leg with wet compresses, which had been thoroughly wrung out, surrounded with dry cloths closely applied. A complete change in diet was made to the juice of raw beef, sometimes a little

cow's milk, strained gruel, barley water, and orange juice. The boy's crib was to be placed near the fire, and the window opened wide for free play of fresh air. A great change occurred during the treatment. The swellings of the wrist and lower limbs subsided; and at the end of a fortnight he made slight efforts to raise himself and move his limbs about. At the end of a month gentle shampooing with oil, and douches of tepid and then cold water were commenced. Ultimate recovery.

Dr. Barlow then discusses the pathology of the affection, and is of opinion that its peculiar features are really due to scurvy. In most of the recorded cases the usual signs of rickets are present, although in a certain proportion of them only to a very limited extent.

Mr. H. W. Page¹ also records an example of acute rickets, or "Subperiosteal hæmorrhage, probably scorbutic, of three long bones in a rickety infant." The swellings involved the shafts of the left femur and tibia, also the upper third of right tibia. The swellings had gradually come on, the neighbouring joints were not affected, and there was no superficial sign of inflammation. Incisions through the periosteum, with removal of blood clots, were made. This treatment, combined with proper feeding, soon produced an amendment, ending in complete recovery. I would suggest that it is very necessary, in similar cases, first to observe the effects of an improved and suitable diet before resorting to removal of the extravasated blood.

¹ *Med. Chir. Trans.*, vol. lxvi., 1883, p. 221; also *British Med. Journal*, vol. i., 1883, p. 620.

CHAPTER XIII.

OSTEOMALACIA.

Syn. MOLLITIES OSSIIUM, MALACOSTEON.

A constitutional disease, usually seen in adults and particularly females, characterised by continuous softening of the osseous tissue, and by deformities resulting from the changes induced in various parts of the skeleton. Trousseau held the opinion that osteomalacia and rickets were identical, and regarded osteomalacia as the rickets of adults. That view of the relation between the two diseases is no longer tenable, the structural changes alone being quite sufficient to separate them. Again, osteomalacia must not be confounded with the fragility of the bone seen in the aged, a condition arising from senile osteoporosis and atrophic changes occurring in old people.

Causes.—The origin of this fortunately rare affection is still involved in obscurity. It is very uncommon in England and France; more frequently observed in Bavaria and on the banks of the Rhine. It attacks adults, particularly women, between thirty and fifty years, and especially those who have had several children. To show the preponderance of the disease in women, Durham¹ mentions that one hundred and thirty-two women and thirteen men were affected in a total of one hundred and forty-five cases. According to the same authority, the largest number occur between twenty-five and thirty-five. Beylard, on the other hand, found the disease most frequent between fifty and sixty, two cases he reports occurred under twenty

¹ *Guy's Hos. Reports*, 3rd series, vol. x., 1864.

and three after sixty. The important influence of pregnancy, as an exciting cause of the disease, is also shown in Beylard's cases, for out of thirty-six cases no less than thirty-one had borne children. In Durham's one hundred and thirty-two cases, ninety-one were attacked, either during or very shortly after pregnancy. The various theories emitted in regard to the causation of osteomalacia are contained in the three following:¹

1. That the rarefaction and softening of the osseous tissue are due to the solution of their lime salts by an acid, such as lactic acid (Weber), carbonic acid (Rindfleisch), or phosphoric acid (Schmidt).

2. That it arises from depraved nutrition.

3. That in osteomalacia a special form of osteitis, with destruction of the osseous tissue and an absence of repair, is observed (Follin, Virchow).

The evidence in support of the first theory does not appear to be satisfactory. Indeed, with our present physiological knowledge, it is difficult to imagine how an acid state of the blood (which, we suppose, is the solvent fluid bringing about solution), sufficient to act on bone so as to remove its lime salts, can be compatible with life.

To show the probable inflammatory character of the affection, the condition of the marrow during the early stage of the disease may be mentioned. Its vessels are distended with blood, hæmorrhages not unfrequently take place, producing spots of ecchymosis intermingled with cells of a rounded or fusiform shape, which to a certain degree replace the fat cells. There may also be extravasations of blood beneath the periosteum, which is itself easily separated from the adjacent bone. Analyses of bones affected with osteomalacia show a diminution in the salts of lime, but the means by which the elimination is carried out remains unsettled. The

¹ Jaccoud, *Dict. de Médecine pratique*, Art., Os.

urine¹ and milk have been repeatedly examined, and in several cases no increase in the calcareous salts determined (Pagenstecher). Some think the materials resulting from the decalcifying process are removed from the system by the mucous surfaces of the intestine and bronchi, and that this circumstance, to a certain extent, explains the catarrhs so often seen during the course of the disease.

Pathology.—The disease consists essentially in an alteration of the nutrition of the bones, which determines a dissolution of the osseous trabeculæ after absorption of the calcareous salts, while the marrow itself, at the same time, undergoes important changes. Two periods in the evolution of the disease are recognised. During the first the bone softens without rarefaction, and preserves its volume. This change extends from the periphery to the centre of the osseous trabeculæ; the margins are deprived of their calcareous salts, while the centre still possesses them. The marrow becomes of a dark red colour, with fewer fat cells; substituted for these we find a connective tissue growth made up of round, fusiform, or flat cells (Cornil and Ranvier). The marrow vessels give way and hæmorrhages very constantly occur, producing a soft, semi-fluid substance of a reddish-brown colour, not unlike spleen pulp.

In the second period decalcification continues to progress, and is accompanied by absorption of the trabeculæ. There is considerable enlargement of the medullary spaces, which are filled with a reddish-brown material, and disseminated through it is a quantity of blood pigment (yellow or brown), either free or limited to the cells. As the changes extend outwards, the compact layer, with the exception of a thin shell on the exterior, is converted into a tissue similar to spongy bone, and in con-

¹ Recent examinations of the urine have led to very contradictory results. In some cases a very marked increase in the lime phosphate has been noticed, while in others there is no such increase, and some have even found a diminution in the quantity excreted. It is possible the source of this discrepancy will be found in the examination being made at different stages of the disease.

sequence of the loss of resistance there occur deformities, varied and often remarkable, together with spontaneous fractures. There appears to be a difference of opinion with regard to the chances of union in bones affected with osteomalacia. Some (Volkmann) contend that they unite like a normal bone, while others (Ranvier) hold that the union is never osseous, or, at any rate, that it is imperfect and not so rapid as under natural circumstances.

Symptoms are at the onset obscure, and consist of sharp, deep-seated, irregular, and intermittent pains, not unlike those produced by periostitis or rheumatism. When the disease sets in soon after a confinement, the pains are situated in the pelvis and lumbar region, spreading therefrom into the thighs. At first they are often intermittent, grow worse at night, and are increased by pressure and humidity of the atmosphere. Standing and walking induce pain. Patient soon becomes tired, and experiences some difficulty in taking a deep inspiration. Deformities are established, and assume certain peculiarities, which are most characteristic. The vertebral column is bent, either backwards or laterally, and very frequently the two curves are found combined.

The deformity of the pelvis has received the particular attention of obstetricians, and often gives rise to immense difficulties during parturition. The sides of the cavity approach each other, while the promontory of the sacrum and the symphysis pubis project forwards, forming the beaked appearance which is so conspicuous and characteristic. There is likewise an alteration, somewhat variable, in the shape of the chest, and largely depending upon the position in which the patient lies; sometimes it is contracted in its antero-posterior diameter, sometimes its transverse measurement is decreased, from the ribs being depressed in the axillary line; in front and behind they often bend outward. The bones of the extremities less frequently attacked assume all manner of curves. The scapula is thickened

along its margins, and the fingers and toes are thickened at their extremities (Charcot). Besides being deformed, the bones undergo spontaneous fracture, which serves only to exaggerate the distortions; and in severe cases the body becomes peculiarly and grotesquely misshapen, the feet in some instances touching the head, as in the celebrated case of Madame Supiot, reported by Morand.¹ The intellectual faculties are generally preserved unimpaired, although a strange nervous susceptibility may exist, to which Trousseau called attention, and in which very painful muscular contractions are induced by merely touching the limbs. In some cases, however, where the cranium is severely implicated, as it often is when the disease attacks males, cerebral troubles may ensue. The digestive and respiratory functions may also be implicated, the patient suffering from diarrhœa or bronchitis, and these complications are sometimes the immediate cause of the fatal issue. When the pelvis is so seriously deformed as to interfere with parturition, the patient's life will be placed in imminent peril, and a Cæsarean section, with all its attendant risks, may be rendered necessary. It should be remarked that when osteomalacia develops in males it shows a preference for the cranium, the ribs, and the bones of the extremities. The same is true of the disease when it attacks females also, at other than during the period of parturition.

Diagnosis.—This is not difficult when the deformities exist, but is at first generally doubtful. The pain, usually the first symptom, suggests rheumatism, and this is often the diagnosis until the deformations show themselves, when the nature of the disease is at once suspected. Between rickets and osteomalacia there are many points of distinction, which serve to distinguish them from each other. The following table, showing the differences, is taken, with some slight modifications, from Agnew's *Surgery*:—

¹ Paris, 1752.

OSTEOMALACIA.

1. Generally a disease of adult life.
2. Affects chiefly females, especially those that have been several times pregnant.
3. Softening progressive, rarely becoming arrested.
4. Attended with severe pains, principally induced by movements, and often located in the pelvis.
5. Absence of epiphysial swelling.
6. Fontanelles closed.
7. Unaffected by treatment.

RICKETS.

1. A disease peculiar to children.
2. Affects males and females indifferently.
3. Softening usually arrested and patients recover.
4. Absence of pain, cutaneous hyperæsthesia in early stages.
5. Epiphysial swellings.
6. Fontanelles and often sutures open.
7. Readily amenable to suitable remedies.

Prognosis.—What has been already said respecting the nature of the affection will testify to its intractable character. It progresses uninfluenced by any remedies, and almost always terminates fatally; death resulting either from exhaustion, from derangement of the intestinal or bronchial mucous surfaces; or from complications associated with parturition. When a cure is effected, the bones consolidate in their distorted condition, and the patient loses much in stature. The duration of the disease varies from two to eight or ten years, and even more. Gestation, when osteomalacia is present, has a very unfavourable effect on the course of the disease.

Treatment.—None is found to be efficacious in arresting the progress of the disease. All we can do is to try and maintain the strength, to relieve the pain, and to minimise the effects of the loss of resistance in the skeleton. With these objects in view, we exhibit tonics such as iron, quinine, cod liver oil, together with a nutritious and even generous diet. Some prescribe phosphate of lime, but it is exceedingly doubtful whether the drug exercises any beneficial effects whatsoever. Opium may be necessary to alleviate pain and to procure sleep. To guard against the bone distortions and fractures absolute rest in the recumbent position should be enforced, and, as in some cases there is a tendency to the formation of bedsores on the sacrum, air cushions, or, better still, a water bed is most de-

sirable. A fracture occurring during the course of the disease demands the treatment ordinarily required in such cases. We can scarcely expect union to take place in the usual time, except perhaps in the early stages of the affection.

The following is a case of osteomalacia in a girl, thirteen years of age:¹ For nearly three years before her death she had been under Mr. Davies-Colley's observation. Family history: Father was rather undersized, but had good health, and he died rather suddenly from the effects of an accident when his daughter was three or four years old. Mother is a diminutive woman, but apparently strong and healthy. She married at thirty-five and had four children, of whom one died in infancy; the patient was the third of the family; the other two are living and in good health, somewhat below the average size, but straight limbed and well formed. No history of syphilis or any tendency to disease. On the evening before her admission into Guy's (October, 1880), while drawing off her stockings as she sat in a low chair, she overbalanced herself, fell forward, and broke her right femur. She was thin, pale, delicate looking, and undersized, with a high, prominent forehead. There was well-marked beading of some of the ribs, and some enlargement of the lower end of the right forearm. She had also genu valgum on each side. It was soon noticed that many of the long bones were remarkably tender, and upon careful examination it was found that they were flexible, and that in some parts of their surface the thin shell of bone could be dented in with a slight pressure of the finger. Tibiæ especially affected. The most apparent deformities were in her arms. What at first sight seemed to be her shoulders were really sharp bends of the humeri about two inches from their upper extremities, and the forearms were so much bent inwards just above the wrists as to be at right angles to the hands. The urine was frequently examined and gave rather

¹ Davies-Colley, *Trans. Pathol. Society*, London, vol. xxxv., 1884, p. 285.

contradictory results. When the sediment was put under the microscope, it was on several occasions found to contain triple phosphate crystals, and latterly it became alkaline and purulent. On the other hand, careful analyses were made by Dr. Stevenson, from which it appeared that the phosphoric acid was markedly deficient, hardly more than a third of what is found in normal urine, while the calcium was in excess. Microscopical examination of the bones showed that the changes closely resembled those of advanced rickets. The irregular proliferation of the epiphysial cartilages and the absence of degenerative changes in the decalcified bone structure were unlike the conditions described in osteomalacia. The case was, however, regarded as one of osteomalacia, and for the following reasons:—1. The fact that the disease did not make its appearance until the patient had reached the age of nine. 2. Its great intractability, for it resisted all treatment by improved hygienic conditions, cod liver oil, and the remedies which are usually successful in rickets. 3. The remarkable thinning and flexibility of the long bones, the rostrated, trefoil-shaped cavity of the pelvis, and the hypertrophy of the skull, with the partial obliteration of its sutures.

Infantile Osteomalacia.—The following example of osteomalacia in a child is reported by Dr. Bury.¹ Specimens of the tibia, radius ulna, and ribs were exhibited to the Section of Diseases of Children at which the paper was read.

When first seen, about a fortnight before death, the child was much wasted and very small for its age. All the limbs were bent; the tibia strongly arched forwards and felt thickened, femur bent outwards and backwards, and the arms and forearms presented an outward curve. The chest was fairly shaped; there were no grooves and no detectable enlargements at the junction of the ribs and cartilages; no history of syphilis. The mother had another child, aged two

¹ *British Medical Journal*, vol. i., 1884, Feb. 2nd.

years and a half, who was quite healthy. At the post-mortem examination the fragility of the bones was very striking. The ribs presented spontaneous fractures near their angles; at the junction of bone with cartilage there was not a trace of beading; the epiphysial line was perfectly straight, and the microscope did not reveal any proliferation of cartilage. On slicing the tibia red pulp bulged out; after washing this away it was found that, beyond a thin shell of cortical bone, the rest of the shaft was filled up with soft, dark red medullary tissue, together with a scanty trabecular framework. The upper and lower epiphysial lines were quite even and not wider than natural.

The first recognised case of infantile osteomalacia was recorded by Dr. Rehn, in 1877.¹ It occurred in a child fifteen months old, which was regarded as rachitic by Virchow. Professor Recklinghausen examined the bones, and concluded that the condition was allied to osteomalacia. Besides the above case, which terminated fatally, Dr. Rehn reported five other cases of what he considered to be osteomalacia in childhood. He has also further examined the question and given his conclusions in a paper published in 1884.² Among the premonitory symptoms³ of the disease are feeble nutrition, marked restlessness, sleeplessness, and especially great irritability on movement. The characteristic signs on which Dr. Rehn relies are great softness and flexibility of the long bones, the epiphyses and ribs being only slightly tumid. Fractures frequently occur in the bones and even in the scapulæ. The intensity of the disease was greatest in the forearm and leg bones, then in the humeri, the femora suffering least. Cranio-tabes present in two cases; anæmia and emaciation were marked in all. The urine did not show any increase of earthy phosphates. Course of

¹ *Ein Fall von infantiler Osteomalacie. Jahrbüch. für Kinderheilkunde*, 1877, Bd. xii., p. 100.

² *Zur Frage der infantilen Osteomalacie. Jahrb. für Kinderheilkunde*, 1884, Bd. xxi., p. 213.

³ As quoted by Dr. Bury from Professor Rehn's paper.

disease chronic, lasting many months. All the cases occurred during the first two years, the disease beginning in the first year, and all were females. From rickets infantile osteomalacia is distinguished by (1) the high degree of softening and the slight epiphysial swelling; (2) the thinness of the whole skeleton; in rickets, thickening of the bones; (3) the straightness of the lower extremities, which in rickets are usually curved; (4) pain on movement much greater than in rickets.

CHAPTER XIV.

TUMOURS OF BONE.

Much confusion formerly prevailed with regard to the morbid growths included in the class of bone tumours. It will be apparent to anyone who consults the works on this subject, of such authors as Petit, Boyer, and Bell, that diseases are grouped together having totally dissimilar structure, growth, and results. Sir Astley Cooper, in speaking of exostoses, divides them into the cartilaginous and fungous, including under the latter term tumours which no doubt belong to the sarcoma group. Since the subject has been studied by the aid of means formerly unknown, many obscure points have been elucidated, and although some things still remain unravelled, our knowledge is not very far from being complete.

Tumours of bone are either connected with the periosteum, originate within the compact tissue, or grow in the cancellous interior. They are divisible clinically into two classes: 1. Benign. 2. Malignant. To these some add a third or a semi-malignant class, which includes one form of sarcoma—the myeloid, clinically often regarded as a benign growth.

1. Benign bone tumours are such as are destitute of the characters usually associated with malignancy. Of these there are several varieties: (1) Osteoma. (2) Fibroma. (3) Myxoma. (4) Lipoma. (5) Chondroma. (6) Cysts. (7) Aneurism.

I shall proceed to describe them in the order in which they are enumerated here, and consider the tumours belonging to the second class in subsequent chapters.

OSTEOMA. *Syn.* BONY TUMOUR, EXOSTOSIS.

The tumours included in this group are composed of perfectly formed bone; when springing from the outside of a bone, osteomata are termed exostoses; when growing from the interior, enostoses.

Two forms of osteoma are to be met with, and they differ according as the compact or the cancellous tissue predominates in their structure: 1. Hard exostosis (including the ivory variety). 2. Spongy exostosis.

Hard exostoses are composed of compact bone, which is often so dense that the term ivory is frequently applied to these bony tumours. The ivory change in the osseous tumour may proceed so far as to destroy its vitality by arresting the circulation in it. In this way the growth may spontaneously separate from the bone to which it has been attached (Hilton¹). Ivory exostoses very commonly spring from the supraorbital region of the skull, and are often connected with its inner surface. They may also originate in the diploë of the frontal region (enostoses) (*figs.* 44, 45, 46), and eventually appear on the outside or inside of the skull, or they may grow through both compact layers. Osteomata also grow from other flat bones, pelvis, scapula, also from the bones of the face, especially the lower jaw.

The spongy exostosis (*fig.* 47) often springs from the vicinity of the epiphysial cartilage of a long bone, where it constitutes a simple deviation from the normal growth. It may also arise from a bone at the point of attachment of some large tendon owing to a sprain. Unlike the ivory exostoses, the spongy osteomata are usually multiple, and originate in cartilage with which they are also generally encased. It is difficult to distinguish such exostoses from ossifying enchondromata. In the latter there are many separate points of ossification, while in a growing exostosis there is only one centre of ossification,

¹ *Guy's Hospital Reports*, vol. i., p. 493, 1836.

and the cartilaginous basis is mixed with fibrous tissue (Stanley¹). Moreover, an ossifying enchondroma has a more rapid growth, and its surface is very irregular.

Spongy or cancellous exostoses, in most instances, manifest themselves before puberty, and usually their growth ceases

FIG. 44. ✓

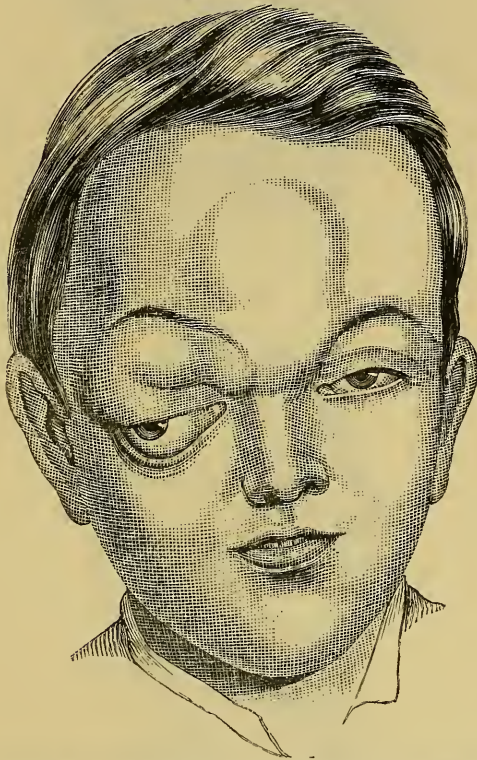


FIG. 44.—Appearance presented before removal of an osseous tumour, enostosis of the frontal sinus; M. 24; recovery (*Mr. Bryant, Guy's Hospital Reports*, 3rd series, vol. xix., 1873-74).

with that of the bone to which they are attached. They are frequently found near the epiphyses of the femur, tibia, and humerus, also in connection with the other bones in almost

¹ *Diseases of Bones*, Lond., 1849, p. 157.

FIG. 45.

FIG. 45.—Frontal portion of the tumour (*Bryant*).

FIG. 46.

FIG. 46.—The portion of tumour removed from the orbit,
natural size (*Bryant*).

every region of the body. Examples are not wanting of several exostoses growing from a single bone, also of numerous exostoses springing from many bones in the same individual (*fig. 48*). Several members of the same family may be affected with exostoses, and there are on record several instances where a distinct heredity was traceable. When an exostosis ceases to

FIG. 47. ✓

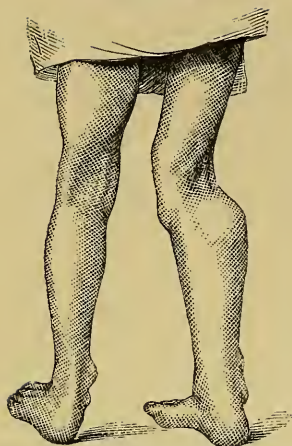


FIG. 47.—Spongy exostosis growing from posterior surface of tibia; removal.

FIG. 48. ✓

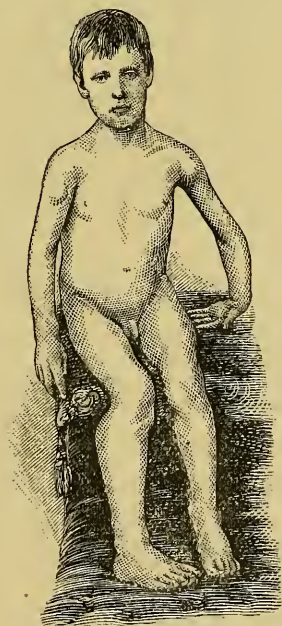


FIG. 48.—Multiple exostoses (see case 28).

grow the cartilage covering it disappears by being converted into bone, which forms a continuous layer with the bone on which the tumour is situated. In some instances spongy osteoma continues to grow after growth of the skeleton is completed, and may reach a considerable size. It is very probable that many lobulated osseous tumours of irregular shape ought rather to be classed among the ossifying enchondromata than with the osteomata.

MULTIPLE EXOSTOSES IN A BOY.

Case 28.—William S., aged nine, admitted into the Children's Hospital, Pendlebury, in July, 1877, on account of a number of osseous outgrowths connected with the different bones of the body. They occupied the following situations: both ends of the right clavicle; the upper end of each humerus, about two inches from the shoulder joint; the carpal end of the right radius, at the root of the styloid process, there was also a considerable enlargement of the lower third of the bone; the anterior and outer surface of the left radius, the lower end of each femur, the upper and inner side of each tibia, the lower ends of both tibia and fibula; also the external surface of the left fibula. In addition to these smaller growths there was a large, firm, irregular mass springing from the posterior surface of the right tibia and fibula, about two inches below the knee. This was removed, and on section was found to consist principally of cancellous bone enveloped in a thin layer of cartilage. Its attachment to the fibula was much firmer and more extensive than to the tibia. There were spiculated growths on the dorsal surface of the ring and middle fingers of the right hand, and on the outer side of second phalanx of left middle finger, together with enlargement of the dorsal surface of the left ring finger immediately anterior to the joint between the metacarpal and second phalanges. The boy also presented a peculiar deformity of the left ulna; the lower third of the bone appeared to be in a rudimentary condition and to join the radius, thereby destroying the power of pronation and supination of the forearm on that side. There was an entire absence of similar bony growths in any member of the family either immediate or remote. The boy had every appearance of good health, and there was no evidence of either syphilis, struma, or rickets. Some three years later this patient entered the Manchester Royal Infirmary, and had an exostosis removed from the inner margin of the bicipital groove on the right humerus. No change in the other exostoses could then be discerned.

Causes.—Sometimes osteomata of the spongy kind, generally multiple, are hereditary.¹ They are also said to be produced by violence. A man in St. Bartholomew's Hospital had a large exostosis growing from the lower and inner part of the

¹ Gibney, *Amer. J. Med. Sc.*, 1876, vol. ii., p. 173; Poore, *Lancet*, 1873, vol. ii., p. 771; Fischer, *Zeitschrift für Chirurgie*, 1879, xl., p. 357; Reulos, *Progrès Méd.*, 1885, No. 31, a remarkable instance.

femur; and he stated that he had been kicked by a horse in that situation shortly before the tumour commenced (Stanley). Many are associated with growth in length of the long bones (exostosis of development), more especially in rickety subjects (*fig. 49*). Syphilis also sometimes produces osteomata as a result of localised inflammation.

Symptoms.—A hard tumour of slow growth, usually free from pain, springing from a bone and unattended by any constitutional disturbance, as a general rule indicates an exostosis.

FIG. 49. ✓

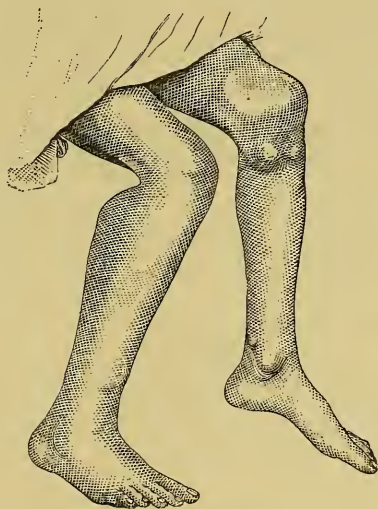


FIG. 49.—Epiphyseal exostoses of the tibia.

The hard cranial exostosis is generally single and of limited extent. In some cases, however, it attains to a large size, filling the nasal and orbital cavities and projecting on the outside and in the interior of the skull. In a case under Dr. Little's care, an osteoma springing from the roof of the orbit, carried the eyeball forwards and caused loss of sight and a distressing deformity. The tumour was successfully removed, but the sight was irretrievably lost.

Of all the bones of the body the femur is most frequently affected with exostosis. It commonly springs from its lower end, and if from the inner side, near to or in the insertion of the adductor magnus, it may offer a serious impediment to riding, the patient being unable to grip the saddle.¹ I believe that army surgeons are always on the look out for this form of exostosis when examining recruits for cavalry regiments.

A gentleman, about thirty-five years of age, came under my observation with symmetrical exostoses springing from the inner surface of the thighs, above the internal condyles. Being fond of hunting, he was very much inconvenienced by them, as his ability to ride was seriously impaired. Over each exostosis a serous bursa had developed, which permitted the integuments to glide over the projections. By adjusting a ring pad, and so removing the pressure, riding was made fairly comfortable. The tibia on the inner side, at or near the insertion of the sartorius and gracilis muscles, is also frequently the seat of exostoses, which are commonly associated with rickets, and connected with development.

EXOSTOSIS CONNECTED WITH OUTER AND LOWER END OF FEMUR ;
REMOVAL.

Case 29.—P. W., aged nineteen years, admitted to the Manchester Royal Infirmary, September, 1887. She has always enjoyed good health. About four years ago she received a blow on the outer side of the lower part of the right thigh, in the situation of the present tumour, which developed soon afterwards. It has gradually but steadily increased in size, and at intervals has occasioned pain of a shooting character. Connected with the lower part of the right femur and on the outer side is a hard, rounded, prominent outgrowth. It is not tender on pressure, is the seat of no spontaneous pain, but induces a considerable amount of aching. The soft parts over it are freely movable, and present no abnormal appearances. The tumour is in close proximity to the knee, and this seemed to contra-indicate any attempt at removal. Two circumstances, however, made the operation necessary—the slow but progressive increase in the size of the growth and its interference with progression. The patient was placed under the influence of chloroform, and an attempt made to fracture the growth, but this was found to be impracticable owing to its broad attachment. An incision was therefore made in the axis of the limb of sufficient dimensions to expose the tumour. While doing this a bursal

¹ The so-called “rider’s bone” results from ossification of the tendon of the adductor longus or magnus muscle.

cavity which covered its free surface was opened. We did not stay to examine whether it was in communication with the knee joint or not, but proceeded to remove the growth by chiselling through its broad base of attachment. Some small, projecting spicula of bone were afterwards separated by a cutting forceps and removed. After the wound had been carefully cleaned with an antiseptic fluid (a saturated and warm solution of fluo-silicate of sodium), the edges of the skin incision were approximated by means of wire sutures, the part covered with wood-wool pads, and the limb placed on a back splint. The after progress of the case was very simple. Its course throughout was afebrile, the wound healed by first intention. The patient left the hospital in about a fortnight. The tumour was composed of cancellous bone tissue, with a capping of cartilage.

The spine is not often affected with exostoses. When, however, they do occur in this situation, they are sometimes attended with serious symptoms. Sir Astley Cooper¹ mentions the case of a woman admitted into Guy's Hospital having no pulse at the wrist or elbow. Her hand was of a venous redness, always cold, generally benumbed, yet seemed painful; there were small gangrenous spots upon it. On examination of the upper part of the arm, these appearances were found to be the consequence of a projection from the lower cervical vertebra² (sixth or seventh, perhaps both) towards the clavicle, and consequent pressure upon the subclavian artery. By means of warmth and friction, the natural heat of the arm and hand was greatly restored, the further increase of the swelling seemed suspended, and, at the time she was discharged, the arm was in a very improved state; nevertheless, the pulse at the wrist had not returned.

EXOSTOSIS SPRINGING FROM THE TRANSVERSE PROCESS OF SIXTH CERVICAL VERTEBRA; REMOVAL.

Case 30.—F. H., æt. twenty-six, admitted into Manchester Royal Infirmary, July, 1887. Patient had very good health till twelve months ago, when she began to feel shooting pains in her right side, a little below the breast. Soon afterwards she noticed a swelling on the inner side of the right breast, and since then this swelling has gradually increased in size. Soon after these pains she experienced a sense of weakness in her right shoulder, accompanied by occasional numbness

¹ Cooper and Travers, *Surgical Essays*, 1818, part i., p. 159.

² Mr. Holmes Coote, *Lancet*, 1861, vol. i., pp. 360 and 409, gives an interesting example of an exostotic growth, the size of a large walnut, springing from the left transverse process of the seventh cervical vertebra in a woman twenty-six years of age. It was successfully removed, and the patient made a good recovery.

reaching down to the upper and outer third of the upper arm. On admission a hard swelling is to be felt on the fourth rib on the right side, close to its junction with the costal cartilage. There can also be felt a hard swelling in the right supraclavicular space, reaching to the under surface of the outer third of the clavicle. She complains of soon feeling tired when attempting to raise the right arm, the hard swelling evidently causing pressure on the circumflex nerve. The veins in the neighbourhood are not enlarged. A small, hard nodule can also be felt on the right side at the junction of the fifth rib with its cartilage. On July 19th, 1887, an incision two inches in length was made above the middle third of the clavicle; on pulling aside the anterior scalene muscle, a bony growth was exposed; this was then removed as near its origin as possible by means of a bone forceps. A drainage tube was now inserted, and the edges of the wound brought together by means of wire sutures, iodoform, carbolic gauze, and a wood-wool pad being the dressings employed. On July 23rd the sutures were removed and the drainage tube taken out. There was no suppuration.

A case similar in most particulars to this was under the care of Mr. Heath, at the Manchester Royal Infirmary, last year. Besides the arrest of the pulsation in the brachial there was very much wasting of the arm, more especially in the parts supplied by the median nerve.

An interesting case of exostosis, giving rise to much occasional pain, was sent to me by Dr. Hodgson, of Oldham. It occurred in a middle-aged gentleman, who complained of pain in the right elbow. On examination nothing abnormal could be detected in the joint, but springing from the anterior and lower surface of the humerus was a small osteoma, which in certain movements of the limb caught the musculo-spiral nerve, producing a sharp neuralgic pain.

A peculiar and troublesome form of exostosis¹ springs from the upper surface, margin, or extremity of the ungual phalanx of the great toe, rarely found upon any of the others. It is often regarded as a disease of the nail, and this has not unfrequently been removed with no beneficial result. The disease

¹ Sir Astley Cooper was the first writer to notice these growths. In 1818, he wrote (*Surgical Essays*): "Two instances of exostosis, under the nail of the great toe, projecting considerably beyond it, have occurred in my practice," one was removed easily with a saw. Mr. Liston published a short paper on the disease in 1826 (*Edin. Med. and Surgical Journ.*, vol. xxvi., p. 27), and seemed to be unaware of Cooper's cases. Dupuytren's first cases were published in 1833 (see *Orales de Clin. Chir.*, t. iii., p. 412).

was fully described by Dupuytren,¹ who successfully operated on a large number of cases, some of them published in his work. The plan of treatment will be gathered from one of his cases.

Exostosis of the Last Phalanx of the Great Toe.—Catherine L., a seamstress, aged twenty, applied to Dupuytren with a hard osseous tumour on the outer and lower part of the left great toe. The progress of its growth had been very slow, as it did not exceed in size a small nut. The patient could not account for its existence. The nail was a little raised by it, but it was not in itself painful, though it occasioned some inconvenience in walking. This exostosis was removed in the following way: The foot being fixed, two semi-ovoid incisions were carried around the base of the growth, and the greater portion of it removed at once. The mass consisted of an external compact substance, and of spongy texture within. The wound healed in a few days.²

It is worthy of remark that the five cases reported in this volume of Dupuytren's occurred in women. This disease occurs generally on the last phalanx of the great toe as a sessile growth, which appears about puberty or at an earlier period, and is more common in girls. It is composed of spongy bone tissue covered with a layer of cartilage. It raises the nail, and pressure of the boot occasions pain and inconvenience in walking. If allowed to grow, troublesome ulceration may ensue. For this and other reasons early removal is counselled, which can be effected after exposure of the growth, while the patient is anæsthetised, by a gouge or bone forceps. The cartilage covering must be completely removed, otherwise a return of the growth may take place. The surface may be covered with wood-wool pads or dressed with carbolic oil; the foot to be placed on a back splint to ensure rest.

¹ *Injuries and Diseases of Bones.* Translated and edited for the Sydenham Society, by Mr. Le Gros Clark. Lond., 1846.

² For additional cases of ungual exostosis, see Southam, *Exostosis of the great toe*, *Med. Chron.*, 1885, vol. iii., p. 381.

Diagnosis.—The diagnosis of osteomata will be determined by what has already been said. The characteristics of hardness, immobility, fixation to a bone, and slow growth generally suffice to separate these tumours from the other benign bony outgrowths. When an exostosis occupies a deep position in one of the cavities of the body—such as the cranium (*figs. 50, 51, 52*) or pelvis—the difficulties attending the diagnosis are

FIG. 50. ✓



FIG. 50.—Exostosis of the frontal bone (*Mr. Birkett's case, published in Guy's Hospital Reports, 3rd series, vol. xvi., 1870-71*).

always great, and sometimes may be insurmountable. A pelvic exostosis, which perforated the bladder, was mistaken for a stone by Cloquet. Dupuytren¹ removed a finger under the impression that a tumour on it was an exostosis; it turned out to be the walls of the bone expanded around a fatty substance deposited within it. Any attempt to diagnose an

¹ *Journal Universel et Hebdomadaire*, Dec., 1833.

osteoma springing from the inner surface of the cranium must be almost impossible, save under exceptional circumstances. Brain symptoms associated with an external exostosis may create a suspicion of an internal exostosis; or the development of cerebral symptoms some time after fracture of the cranial vault may induce us to suspect an internal exostosis, or splinters or depressed fragments of the inner table, which, instead of being partially absorbed and smoothed down, remain angular, grow, and become as hard as ivory (Pollock¹).

FIG. 51.✓

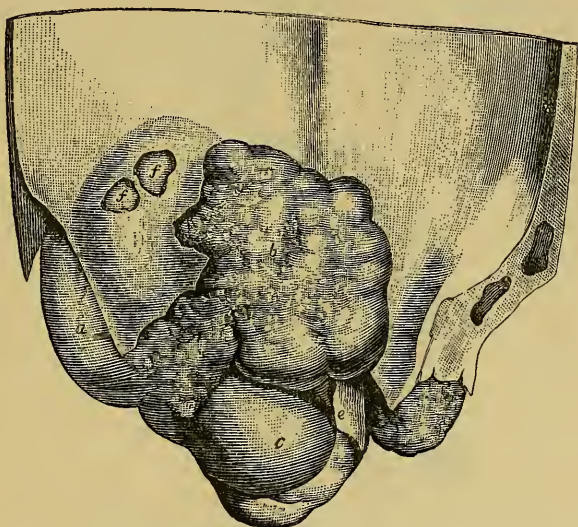


FIG. 51.—Internal or cerebral surface of frontal bone, showing osseous growth (*Birkett*).

Emmert's case, quoted by Pollock, affords an exceedingly good example of this latter condition: A countryman, twenty-two years old, who had met with an injury to the head six years previously, suffered from continuous pain, more or less violent, at the seat of the scar; then came occasional vertigo, loss of memory to a great extent, and melancholia. The brain

¹ *St. George's Hospital Reports*, vol. ii., 1867, p. 14.

symptoms increased, so that the patient could no longer quit his bed; the upright posture being immediately followed by vertigo. Examination showed that the injured spot was pretty nearly confined to the right frontal eminence, where the bone was swollen and slightly prominent. This led Emmert to think that the brain symptoms might possibly depend upon an internal exostosis, the result of the injury. Trephining was proposed and accepted. The thickened part of the skull was laid bare, and a piece of bone an inch in diameter removed

FIG. 52. ✓



FIG. 52.—Profile view of a vertical section of the frontal bone, with bony growth (*Birkett*).

with a large crowned trephine. The excised portion of bone was unusually thick, and showed on its inner surface, pretty nearly corresponding to the external thickening, a ridge of bone transverse in direction projecting abruptly to the depth of two lines, and four lines broad by eight long. The diploe at this point had disappeared for the most part, and the tissue of the bone was hardened—sclerosed, as the result of inflammation. The dura mater was natural in appearance. Soon after

the operation the pain in the head ceased, the other symptoms gradually disappeared, and six weeks afterwards the patient was restored to his former good health.

Prognosis.—The prognosis, favourable as regards the osteoma itself, will vary with the position which the growth occupies. When in the vicinity of organs essential to life, we must view it with grave concern; such is the case in the exostoses placed on the inner surface of the skull, which frequently give rise to epilepsy, terminating fatally. In some cases an internal exostosis connected with the frontal bone has pressed in upon the brain without producing a single cerebral symptom, the patient not suffering even from headache. The progress of a cranial exostosis is usually slow, may be almost imperceptible, and its growth may cease at a very early period from its scanty blood supply being completely cut off. In J. L. Petit's case an ivory exostosis, measuring four inches in circumference, had been growing for seven years at the time of the patient's death. Occasionally, the increase in size is more rapid. It happens sometimes that an eburnated exostosis, after attaining a large size, dies, in part or altogether, and is separated from its connections as an irregular mass of necrosed bone. This happened in Hilton's case, where a large necrosed ivory exostosis, weighing fourteen ounces, separated spontaneously from the antrum. The man showed himself at Guy's thirty years afterwards in good health. There is no record of a similar occurrence in the skull, but the thing is possible.

Treatment.—Speaking generally, and admitting but few exceptions, the policy of non-interference should be observed in the case of a cranial exostosis. Its density and broad attachment, together with the uncertainty in regard to the exact limits of the growth, demand the exercise of great caution. It may be deemed prudent to undertake its removal in the event of troublesome brain symptoms occurring; the risks of the operative interference, however, must be fairly placed before the patient, and the surgeon must not lose sight of the fact

that enormous and perhaps insurmountable difficulties will have to be encountered. I remember a case in which an attempt to remove an ivory-like exostosis on the frontal bone had to be abandoned, the patient dying in a few weeks with an abscess in the anterior part of the brain. Cranial exostoses have been sawn off on a level with the skull, and this, whenever possible, is perhaps the best mode of procedure. Caustics have at times been successfully employed in the removal of even the hardest ivory exostoses. Sir Astley Cooper¹ tried in vain to remove a growth from the upper margin of the orbit by means of a saw, and after long-continued efforts the operation was abandoned. Some years afterwards the patient was admitted into St. George's Hospital, under Mr. Keate, who, after repeated applications of nitric acid, ultimately had the satisfaction of seeing the exostosis drop off bodily.

Another case, also under Mr. Keate, terminated in an equally satisfactory manner. Vain attempts had been made to remove with the crown of a large trephine an ivory exostosis which grew from the orbit. Caustic was subsequently applied, and the whole tumour eventually dropped off.

In the application of a caustic, nitric acid or potassa fusa, some caution must be observed. It should be applied to the exostosis itself, and not to the surrounding bone; a neglect of this precaution may possibly lead to intra-cranial inflammation. When, on the other hand, the chisel and mallet are employed for the removal of a cranial exostosis, it is advisable to attack the bone around the exostosis, which in this manner may be removed in a mass.

Exostoses² growing from the articular ends of the long bones of the extremities—many of them associated with some departure from the normal growth, particularly in persons suf-

¹ Pollock, *St. George's Hosp. Reports*, vol. ii., p. 20.

² Those connected with the outer and lower part of the femur sometimes cause pain from irritation of the muscles, producing irregular contractions. This can be relieved by subcutaneous myotomy.

fering from rickets—should be left alone, except when they occasion some inconvenience, either from their size or their situation. The removal of those in the vicinity of large joints is attended with some considerable risk, as the adventitious bursa which forms on the surface of the osseous growth may, and frequently does, communicate with the neighbouring articulation, which may be seriously compromised in any operative procedure undertaken. And here I must make another observation with respect to these bursal cavities, which may be prolongations from the synovial sac, they sometimes inflame, cause an increase in the swelling, which at the same time becomes painful—an unusual symptom in the course of a simple exostosis; this inflammatory swelling subsides with rest and an evaporating lotion. When a bony outgrowth is attended with much inconvenience, its removal may be accomplished either with a cutting forceps, chisel, or a saw, according to the thickness of its base of attachment. Some exostoses possess a cavity which may be continuous with the medullary canal of the bone on which they are placed. This may lead to a suppurative osteomyelitis when the canal is opened on the removal of the growth. The necessity of observing strict antisepticity is therefore a prime duty. Follin fractured a pedunculated exostosis, prevented it from uniting by moving it from time to time, and subsequently removed it.

Maunder,¹ in a case of exostosis of the thigh, adopted the method of breaking the exostosis off subcutaneously. The integuments covering the tumour were protected by a piece of leather, and the growth laid hold of with a large pair of pliers, and broken off with comparative and unexpected facility. Three months later it was noted that the exostosis had reunited, but in a much less inconvenient position than before the operation. It then projected outwardly in a marked degree, and could not be handled without causing the girl great

¹ *Lancet*, July 25th and Nov. 7th, 1874.

pain. It also prevented extension of the leg upon the thigh, and thus rendered the patient comparatively helpless. The head of the tumour, after the operation, became displaced inwards; was absolutely free from tenderness, and the patient had perfect use of the limb. It is worthy of consideration whether, after fracture, some means to prevent reunion should not be adopted. This might so impoverish the blood supply as to lead to the disappearance of the exostosis.

Such a result actually occurred in a case recorded by Professor Chiene.¹ A lad, fourteen years of age, presented himself with a hard, movable tumour, under the muscles of the thigh, above the inner condyle of right femur. The lad received a blow twelve months previously on inside of right knee. Swelling followed, and, when this had subsided, he noticed a hard lump, which could be easily moved backwards and forwards. The diagnosis was that an exostosis had been broken off. Soon after this the tumour began to diminish, and a year later, two years after the accident, a careful examination revealed only a slight linear projection, an inch in length, above internal condyle.

Another mode of dealing with exostoses consists in exposing and depriving them of periosteum. This plan was suggested by Sir A. Cooper, but the results have not been encouraging. Occasionally necrosis of an osteoma follows an injury. Stanley² had under his care a man with numerous exostoses (rickety), and in the centre of one, over the head of the ulna, necrosis took place. It resulted from a knock, which caused inflammation with tenderness. An abscess gradually formed. The whole of the morbid growth was removed by means of the saw and bone forceps, and recovery ensued. The exostosis,

¹ *Edin. Med. Journ.*, July, 1874. Professor Lister (*Edin. Med. Journ.*, May, 1857) removed an exostosis of the upper end of the humerus, which had accidentally been broken off. Poland (*Guy's Hospital Reports*, 3rd series, vol. xvi., 1871, p. 481) relates a case in which an exostosis connected with lower end of femur was accidentally fractured; it reunited, and was afterwards removed.

² *Medical Times and Gazette*, vol. ii., 1853, p. 39.

composed of dense osseous tissue, had a cavity in its centre, which contained a sequestrum the size of a filbert.

When it is decided to remove an exostosis in close relationship to important structures, whether vessels¹ or joints, great care must be observed in carrying out the requisite manipulations. A bony outgrowth from the first rib, near its spinal connections, will demand careful and deliberate dissection. In an example given by Birkett² of a bony tumour springing from the rib close to the subclavian artery, and with the cords of the brachial plexus passing over it, an incision was made parallel with the external jugular vein behind the growth. The knife was employed very sparingly after the integuments were divided. The artery had to be moved cautiously aside, and the growth, which sprang from the rib close to the margin of scalenus, was removed in two pieces. It was made up of ordinary cancellous tissue, with a thin layer of investing cartilage.

No internal treatment seems to influence the growth of exostoses. When a syphilitic taint is suspected, iodide of potassium or mercury must be administered, with the application of a mercurial plaster when the growth is superficial.

*Odontoma*³ is the name given by Virchow to tumours of the teeth and of the neighbouring tissues, of which several varieties are described. These are: 1. Exostosis produced by inflammation of the alveolo-dental periosteum. 2. New growths made up of enamel and ivory, either at the neck of the tooth or on the cement. 3. A peculiar growth springing from the maxilla, and composed of one or more normal or deformed

¹ Dr. Boling, in the *North American Med.-Chir. Rev.*, 1857, p. 608, relates a remarkable case in which an exostosis, springing from the back part of lower end of femur, perforated both popliteal artery and vein, producing an immense extravasation of blood. The limb was amputated, and the patient, a lad, aged sixteen, recovered.

² *Medical Times and Gazette*, vol. i., 1871, p. 602.

³ An interesting account of odontomes will be found in Mr. Salter's papers, *Guy's Hosp. Reports*, 1868, 3rd series, vol. xiv., p. 463; also same series, vol. xxi., 1876, p. 213.

teeth, sometimes welded together or grouped, in consequence of some congenital vice of formation. 4. Teeth implanted in osseous plates.

Odontomes were originally described by Broca, in a paper read before the Academy of Sciences of Paris, in December, 1867. The condition had previously been recognised by Forget and Tomes, but the specimens were placed among the ordinary exostoses.

The most important form of odontoma met with in ordinary surgical practice is the one which arises from some abnormality connected with the development of the molar teeth in the lower jaw. Instead of a cap of dentine, an irregular mass of dental tissue is formed, quite unlike a tooth. A dense tumour expands the bone, in which there is no pain, unless the mass should interfere with the development of the wisdom-tooth or be mistaken for a misplaced tooth or a sequestrum, when acute inflammation may be excited in the jaw itself by ineffectual attempts at removal (Heath). I have known periostitis and necrosis of the lower jaw follow an unsuccessful effort to remove an odontoma, which was producing a good deal of discomfort at the time, when a wisdom-tooth should appear.

Treatment, when the tumour is attended with discomfort, exploration and subsequent enucleation is indicated.

FIBROMA.

Fibromata spring from the periosteum, and most of them are connected with the bones of the face and of the skull. Familiar examples of such growths are the harder kinds of naso-pharyngeal polypi, which arise from the outside of the base of the skull. They also occur in the antrum, and in connection with the lower jaw (*figs.* 53, 54), where it becomes very difficult, in many instances, to effect a differential diagnosis between them and such tumours as the chondromata and exostoses. Paget¹ figures a fibrous tumour, situated within

¹ *Lectures on Surgical Pathology*, 3rd edition, 1870, p. 487.

FIG. 53. ✓

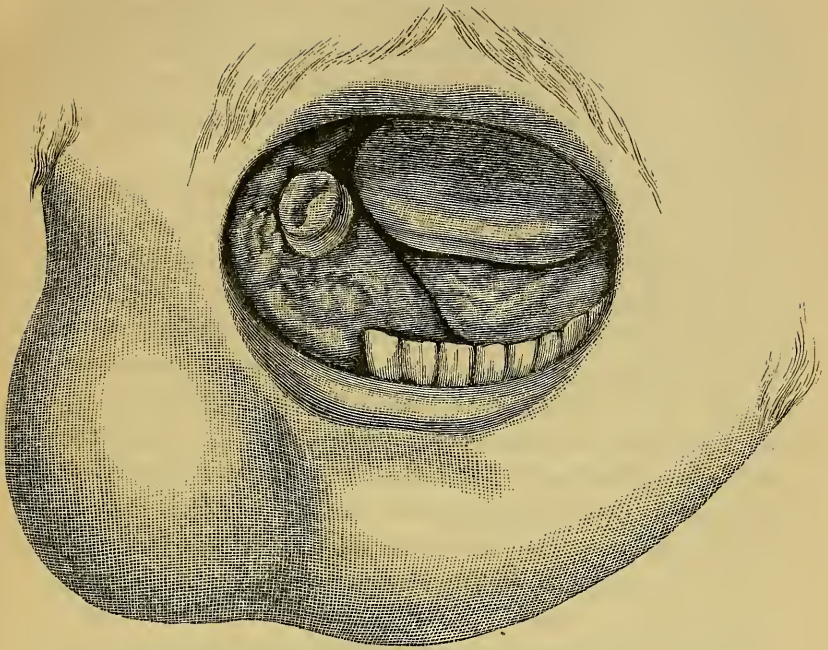


FIG. 53.—Tumour of the inferior maxilla—fibroma (*Bryant, case reported in Guy's Hospital Reports, 3rd series, vol. xix., 1874.*

FIG. 54. ✓

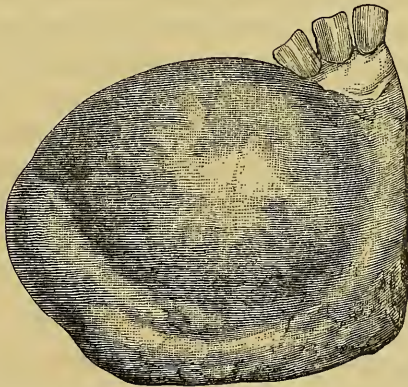


FIG. 54.—External appearances of the fibrous tumour of lower jaw after removal (*Bryant*).

the ramus of the lower jaw (central fibroma), disparting and expanding its walls. It was made up of perfect and unmixed fibrous tissue. There is every reason to think that many of the fibrous tumours of bone described by the older pathologists belong to the fasciculated form of periosteal sarcoma (see naso-pharyngeal polypi).

The fibrous form of naso-pharyngeal polypus is usually attached to the periosteal covering of the basis cranii, and is most commonly connected with the basilar process of the occipital bone, or the body of the sphenoid. It is either pedunculated or sessile, occurs in young adults, grows slowly, is very vascular in certain cases, and is prone to recur after removal. It is composed of fibrous tissue, with no elastic fibres, and often contains sarcomatous elements. Its surface is smooth and firm, and its growth is often attended with much inconvenience and deformity from extension of the mass in various directions. The soft palate may be displaced forwards, the nostrils blocked, or it may extend into the orbit, sphenomaxillary fossa, or even into the cranium. It is occasionally spontaneously detached, or it may exhibit a tendency to cease growing¹ and to atrophy after the age of twenty-five, a point insisted upon by Legouest² and Gosselin.³

Symptoms.—At the outset the symptoms may be very slight, consisting of a sense of heaviness and interference with the passage of air through one nostril. There may be a troublesome nasal discharge, with occasional attacks of epistaxis; as the growth of the polypus proceeds one or both nostrils will become blocked, and some difficulty in breathing and swallowing will exist owing to the displacement of the soft palate and the filling up of the back of the mouth. Hearing may be

¹ Samondes, *Du temps d'arrêt dans la marche des Polypes Naso-Pharyngiens*, Thèse de Paris, 1878.

² *Gazette des Hôpitaux*, 1865, also Sédillot et Legouest, *Traité de médecine opératoire*, Paris, 1870.

³ *Traitement chirurgical des polypes des fosses nasales et du pharynx*, Paris, 1850, and *Clinique chirurgicale*, Paris, 1873.

impaired, and cerebral symptoms intervene should the growth reach the interior of the skull. The maxillary bones may be pushed bodily forwards, producing the hideous and well-known deformity of "frog-face."

Treatment.—Small growths with a pedicle may be removed with a forceps or snared with an ecraseur, the loop being passed through the nostril and hooked over the base of the tumour by means of a finger in the mouth. Owing to the size and the great difficulty in determining the attachment of the larger polypi, the mode of proceeding will be different. The growth may be attacked from the mouth by slitting the soft palate, or the manipulations are conducted from the front by separating the upper lip (Rouge's operation), or by removing a portion of, or turning back, the superior maxillary bone (Langenbeck's osteoplastic resection). In some cases, when the growth is very vascular, the patient is so prostrated from repeated losses of blood and suffering as to be quite unfit to undergo a serious and prolonged operation. Electrolysis might be then adopted with a fair prospect of accomplishing some good. By this means the bleeding has been stopped and the size of the growth so diminished as to render its removal through the ordinary channels an easy matter. The admixture of sarcomatous elements will make a recurrence probable.

Fibroma springing from the periosteum of the long bones is an uncommon disease, and may very easily be confounded with sarcoma; it may, indeed, form the starting point of such a growth. The only means of distinction which we possess are obtained from the history, whether the rate of growth has been rapid or very slow, and whether the tumour has invaded the surrounding structures. Slow growth, with non-implication of the tissues will be in favour of a simple growth, and its removal may be accomplished without sacrificing the limb. Fibromata often calcify, but show little tendency to ossification; they may, however, undergo mucous, fatty, or cystic degeneration.

One form of epulis, the fibrous, is in close connection with the periosteum of the alveolus. It constitutes a roundish, firm, dense, slowly-growing tumour, made up of white fibres, with scarcely any intersecting bands except such as may divide it into lobes, and often in its interior will be found minute spicula of compact, white, bony texture (Paget). In its removal, a portion of the bone with which it is closely incorporated should be taken away, or we should bring about exfoliation of the small bony projection on which the tumour lies, with the actual cautery (Billroth).

MYXOMA AND LIPOMA.

Myxomata and lipomata of bone are pathological curiosities, and scarcely of any clinical interest. The myxomata first described by Virchow are very rare as separate tumours; they are usually found mixed with other new growths such as the chondromata and sarcomata. They are described as rounded subperiosteal growths, causing absorption of the underlying bone, but never infiltrating it. They grow slowly, and only recur when their removal is incomplete. The myxomata are said to be frequent in the jaws.

The lipomata are also rare, but have been described in the upper jaw¹ and in the tibia (Cornil and Ranvier). In the latter case a large tumour had developed in the shaft of the tibia, the lobules of fat, instead of being bounded by fibrous septa, were separated by osseous trabeculæ, and the compact tissue of bone was transformed into spongy tissue. Virchow does not admit the existence of bone lipomas; according to him the tumours so described are merely exostoses which contain a large amount of fatty marrow.

CHONDROMA.

Chondromata are the most common of all the simple tumours of bone. Virchow divides them into ecchondromata and enchondromata.

¹ Viard, *Bull. de la Soc. Anat.*, May, 1850; also Triquet, *Comptes rendus*, 1^{re} série, t. iii., p. 43.

Ecchondromata—Ecchondroses.—The osseous ecchondromata spring either from a conjunctive or a sutural cartilage. They are occasionally met with at the level of the occipito-sphenoidal suture, where they grow from the cartilage in this situation. They may remain cartilaginous or ossify, when they bear a strong resemblance to the osteomata.

FIG. 55.



FIG. 55.—Chondroma, attached to the outer surface of the humerus.
Spontaneous fracture (*O. C. Museum*).

Enchondromata never arise from cartilage. They are heterologous growths, and are connected either with the outside of a bone (*fig. 55*), when they are called perichondromata, or spring from the interior, enchondromata proper.

Cartilaginous tumours vary much in size, often they constitute small nodosities, occasionally they attain to dimensions truly colossal. Thus Nélaton¹ records a case of chondroma of the humerus, the circumference of which was greater than that of the body. In Mr. Lloyd's² case a cartilaginous tumour, surrounding the upper two-thirds of a girl's tibia, grew to a circumference of two feet in about eighteen months. The greatest size is reached by the perichondromata, which arise from the cylindrical bones, and some of the flat bones.³ On the surface, cartilaginous growths are sometimes smooth, generally lobulated; and in consistence usually firm and elastic, sometimes soft and even fluctuant, not throughout their structure, but only in limited parts. They are usually composed of embryonic hyaline cartilage. In some instances, but not often in bone chondromas, cartilage structure is mixed with fibrous or mucous tissue, or there may be cysts scattered through it; hence the varieties fibro-, myxo-, and cysto-chondroma. When sarcomatous elements are mingled with the cartilaginous basis, the character of the growth is very materially modified, and generally it acquires the features of malignancy (chondro-sarcoma).

Central Chondromata—Enchondromata proper.—In these we find the nodules of cartilage scattered through the areolæ of the spongy tissue, which present evidences of vascularity. As the nodules grow, the compact layer is expanded, thins, and may ultimately disappear in parts. When the tumour is enclosed in an osseous shell, it is smooth, and becomes lobulated when this disappears. Sometimes, but very rarely, the growth is surrounded with a thickened layer of bone, the result of a condensing osteitis. The nodules, instead of being limited to one part of a bone, may be scattered through its entire

¹ *Path. Ext.*, 1868, t. i., 481; 1869, t. ii.

² Paget, *Surg. Path.*, 3rd edit., p. 506.

³ Birkett mentions an immense enchondroma connected with the scapula. Its circumference was thirty-eight inches. *Guy's Hosp. Rpts.*, 3rd series, 1866, vol. xii., p. 403.

length; in this way forming several isolated growths, which afterwards become blended together. This fact is important in connection with the question of local recurrence.

Perichondromata are found on the outside of a bone, between it and the periosteum, which itself becomes thickened, and sometimes cartilaginous. We find them principally in connection with the flat bones, where, on the contrary, the central enchondromata are rare. They may be sessile and connected to the subjacent bone by outgrowths of new bone, or they are pedunculated. Usually they are nodulated, and invested with a fibrous capsule, which sends prolongations between the component masses. The presence of a capsule is an indication of the benign nature of the growth.

Chondromata are peculiarly liable to attack the small bones of the hand¹ (*figs.* 56, 57) and foot, then the long bones of the extremities; they are also found in connection with the scapula, pelvis, ribs, and maxillæ (very rare), and most of the other bones. Chondromata are often multiple, especially those on the fingers. They undergo various nutritive changes. They always calcify in the centre, and true ossification may occur as in the normal growth of bone. As a rule, ossification is only partial, even when the tumour has existed for many years. The enchondromas may also undergo a mucous change (chondro-myxoma). Again, a granular fatty degeneration with the formation of cysts is sometimes observed (cysto-chondroma). Lastly, a sarcomatous change may take place in the connective tissue stroma resulting in the formation of a growth (chondro-sarcoma), in which recurrence frequently occurs.

In the osteo-chondromata ossification is observed, and in the chondro-fibromata there is a predominance of fibro-

¹The phalanges are much more frequently attacked than the bones of the metacarpus, and the carpus seems to enjoy complete immunity. The seat of predilection is the metacarpal phalanx. Male sex, youth, and traumatism are predisposing causes (*Dict. de Méd., Art., Main*).

cartilage in the primary cartilaginous islets, and in the stroma which unites them. Chondromata may also soften, ulcerate, and even necrose.

FIG. 56. ✓

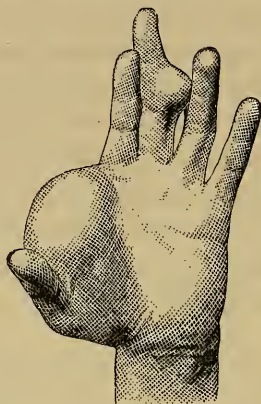


FIG. 56.—Multiple enchondromata of the hand (*Mr. Southam's case*).

FIG. 57. ✓

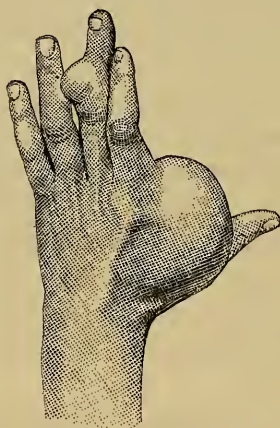


FIG. 57.—Same hand, posterior view.

Etiology.—In the production of chondromata the influence of injuries is variously estimated. Among those who admit traumatism as a directly exciting cause are Virchow, Polaillon,

and Weber, many others, however, still remain sceptical on this point. A medical man found a small cartilaginous tumour develop on the fourth finger of the left hand, due, as he supposed, to an injury received while he was wearing a ring on the finger. A child received a blow from a stone on the hand, and an enchondroma soon appeared at the point struck (Dolbeau¹). Heredity appears in a marked manner in some cases of enchondroma; thus a cartilaginous tumour repeated itself in three generations in Weber's case.² Paget reports a case where a man with an enchondroma of the radius had a daughter who died of a pelvic chondroma.

Enchondromata are sometimes congenital, but the most common age at which they develop is between five and fifteen years. Their appearance in the adult is rare and in the aged exceptional. According to Virchow, the perichondromata develop at a more advanced age than the central enchondromata and their course is more grave. From statistics, it would appear that men are attacked with chondromata twice as frequently as women.

As a rule, chondromata are elastic and hard, but their density varies. Their surface is sometimes smooth, at other times lobulated. They are generally sessile. They may be no larger than a filbert or they may grow to an enormous size. The skin over them is usually free, movable, and of a natural colour; occasionally it thins from pressure and ulcerates. The amount of functional disability will vary with the region attacked. When the tumours are multiple, situated on the fingers, and have attained any size, they may produce serious inconvenience or total disablement. When connected with the bones of the face, which is not at all common, an enchondroma will cause distressing disfigurement.³ In the limbs chondromata will

¹ *Sur les tumeurs cartilagineuses*, Paris, 1858.

² *Gazette heb. de méd. et de Chir.*, 1866.

³ See case in Billroth's *Clinical Surgery*, p. 98.

induce atrophy of the muscles; while the weight of the growth and the deformity it produces will impede motion very decidedly.

In certain situations circulatory troubles will declare themselves. There may be œdema with a superficial network of veins becoming visible. There is often an absence of pain, or it may be of a shooting or continuous character. Should the soft structures covering the tumour give way from any cause, whether from pressure of the growth, the application of irritants, or from external violence; any fluid that exists will escape, the cavity that remains suppurates, and the tumour may be partly eliminated; the patient will then be threatened with additional complications from absorption of the products of putrefaction.

A central enchondroma presents the following peculiarities, which serve to distinguish it from the chondromata springing from the outside of a bone. The growth is smooth, of a fusiform shape, continuous with the bone, which is increased in size, without any distinct line of separation between the two, firm and elastic on pressure, with parchment-like crepitation where the osseous shell is thin and perforated.

A perichondroma is of an oval shape, irregular and bossy on the surface, often slightly movable when the base of attachment is narrow. Clearly demarcated from the bone, which is normal in size, above and below the spot whence the growth springs. It is less firm than a central enchondroma, and its consistence varies in different parts of the tumour.

Diagnosis.—The firm, elastic, tuberous, often multiple growths connected with the fingers or toes, which appear before puberty, are unmistakable. A single cartilaginous tumour may be less easy of recognition. In this case, however, the age at which it appears, its slow increase, together with the characters already specified, will assist in the discrimination.

Exostoses are harder, tapering, always fixed, and have a

smooth surface. They are often multiple when in connection with the larger bones, and throughout they retain the same peculiarities.

Prognosis.—Chondromata are usually local and benign. Certain forms, however, possess undoubted malignant characters, and may infect neighbouring tissues, glands, or they grow into veins and are thus carried to distant parts. There exists abundant clinical evidence that enchondromata, even when made up of pure hyaline cartilage, may take on a malignant character. In the hand, recurrence is observed once in fifty cases (Polaillon). Dolbeau¹ regards cartilaginous growths springing from the long bones as of a graver nature than those connected with the fingers. Weber and Virchow have shown that the cartilaginous disease may be diathetic, that the tumours obstinately recur, and sometimes generalise throughout the organism. Chondromata must, therefore, be regarded as tumours of doubtful and variable prognosis; simple, as a general rule, but possibly malignant. It would appear that the prognosis becomes more serious the nearer the enchondroma approaches the centre of the body and the more advanced the age at which it appears.² Recurrence and generalisation, exceptional for those of the extremities, are not very rare in those of the large bones, and become common in those of the pelvis, face, and thoracic parietes. The lungs are most frequently secondarily affected. Apart from this, cartilaginous tumours are often serious from their size and situation. When attacking the fingers they may effectually prevent the patient from engaging in any manual work, and so be attended with serious consequences. When connected with the long bones of the extremities, they may lead to fractures which consolidate slowly; and their inconveniences become still

¹ Mémoire sur les tumeurs cartilagineuses des doigts et des metacarpiens, *Archiv. Gén. de Méd.*, 1858.

² Mercie, De l'enchondrome des os, Thèse de Paris, 1884.

most manifest when they spring from the pelvis, where they not uncommonly give rise to serious mechanical obstruction.

The circumstances which influence the prognosis are very varied. Besides those mentioned above, it is necessary to take into consideration the possibility of surgical intervention. When arising from some part of the body on which we cannot operate, or where an operation might be attended with grave consequences, the prognosis is obviously more serious than in those cases where an enchondroma is so situated that removal is easily practicable. Those located in the pelvis, which are often inaccessible, are among the gravest forms of enchondromata.

Treatment.—The only efficacious methods are removal of the growth or amputation of the limb on which the tumour is placed. When the tumours are multiple and not attended with any real inconvenience they may be left. Extirpation will be complete or incomplete according as we remove the whole of the tumour or a portion of it only. Examples of incomplete removal with no recurrences are mentioned. Bruns¹ removed a central enchondroma of a metacarpal bone, preserving the latter, although a portion of the growth remained. No recurrence two years afterwards. A cartilaginous growth,² a little larger than the head of a newly-born child, was attached to the fifth and sixth ribs, and to the right of the sternum, it had been growing for fourteen years. On removal it was discovered that the tumour penetrated deeply into the intercostal space, and could not be completely extirpated. After some suppuration, portions of the morbid growth were extruded; finally a cure, with no recurrence at the end of thirteen years.

When an enchondroma occupies the centre of a phalanx, it is quite possible to remove the tumour without sacrificing the

¹ Mentioned in Dolbeau's memoir, already referred to.

² *Gaz. Hebdom. de Méd. et de Chir.*, 1882.

digit. This should be done with a scalpel and spoon, the whole of the growth being taken away, leaving the osseous shell, which ultimately fills up and cures.¹

Cases in which complete extirpation has been practised in large enchondromata of long bones are much more rare. Nélaton² gives two cases where he successfully resected the upper end of the humerus, preserving the arm, and restoring all its movements. Enchondromata attached to the scapula have been treated by removing the whole of the bone, leaving the arm intact.

In some cases the growths are implanted on the bones in such close proximity to joints that the latter are unavoidably opened during their removal. Such an event occurred in a case where a small fibro-cartilaginous tumour was attached to the back part of the tibia, in intimate relation with the capsule of the knee joint. During the operation, the articulation was opened, this in no way affected the course of the healing. In another similar case, I should be inclined to cut off the tumour on a level with, but external to the capsule, for, although this would mean a portion of the growth being left, yet the chances of recurrence are very small, and it is highly desirable to leave the joint intact. An operation was rendered necessary in consequence of the small growth occasionally getting nipped between the joint surfaces, which produced great inconvenience and even prevented the man from following his occupation. Poland³ met with a case in which a tumour springing from the front of the trochanter major was so intimately connected with the capsule of the hip joint that during the operation the articulation was laid open. This did not lead to inflammation or any evil consequences, although it protracted the recovery.

Amputation for cartilaginous tumours may be carried out

¹ For cases, see Sédillot, *De l'évidement des os*, Paris, 1860; also Aubert, *De l'enchondrome de la main*, Thèse de Lyon, 1882.

² *Pathol. Ext.*, t. ii., 1869.

³ *Guy's Hosp. Reports*, 3rd series, vol. xvi., p. 479.

either in the continuity of the affected bone, at the next articulation, or through the bone above, according to circumstances. The following case is remarkable for the boldness with which an exceedingly difficult operation was executed :—

ENCHONDROMA OF THE PELVIS; REMOVAL WITH LIGATURE OF THE COMMON ILIAC ARTERY AND VEIN; CURE.¹

Case 31.—It occurred in a girl eleven years of age, apparently otherwise healthy. Narcosis was induced, and bimanual examination showed the existence of a tumour the size of a man's fist, hard, with well-marked uneven surface, very slightly movable, round, everywhere covered with intestines, getting smaller towards posterior half of the true pelvis where it was attached, near the sacro-iliac synchondrosis. Its relations to the large pelvic vessels could not be ascertained. As the tumour had distinctly increased in size during the two months it had been watched, Bergmann undertook the difficult operation at the express wish of the parents. An incision similar to that adopted in ligature of the common iliac artery was adopted. After dividing the muscular and other structures and pushing the peritoneum on one side, the tumour was exposed, and it was soon found that it would be impossible to save the large vessels because of their implication in the cartilaginous tumour. Attempts to save them led to rupture of the vein. Bergmann therefore decided to ligature the common iliac, external iliac, and hypogastric arteries, also to place ligatures on venous plexuses. After this the isolation of the tumour became easy. Its connection with the pelvis was not extensive; a single blow with the chisel sufficed to divide the narrow pedicle adhering to the posterior part of the linea arcuata interna. The ureter and crural nerve were not seen. The cavity of the wound was disinfected with ethereal solution of iodoform, drainage, and suture in layers, of the wound in the abdominal parietes. Six months afterwards the patient was in perfect health. Operations for bony tumours of the pelvis should be restricted to rapidly-growing exostoses and enchondromata, which must be hard, firm, and well localised. Manual examination of the base of attachment will generally demonstrate whether operation is practicable.

ENCHONDROMA OF THE FEMUR; AMPUTATION; GENERALISATION OF THE TUMOUR IN THE LUNGS AND HEART.²

Case 32.—A young man, twenty-two years of age, of robust constitution and healthy family history, had a cartilaginous tumour springing from the lower and inner surface of the left femur. The thigh was amputated and he made a good recovery. A short time afterwards cerebral troubles appeared and he became aphasic. Within the next twelve months symptoms pointing to implication of the lungs declared themselves, and he died of asphyxia. On the surface of the right lung a small cartilaginous tumour was discovered, also a white firm growth in the lower part of the left lung, and a third one on the anterior surface of the right ventricle. The growths examined microscopically exhibited the structure of an enchondroma.

¹ von Bergmann, *Deutsche Med. Wochenschrift*, 1885, No. 42 and 43.

² *Lyon Médical*, October 10th, 1886, No. 41, p. 167.

CYSTS.

Cysts in bone are tumours made up of one or more cavities containing fluid of variable nature and consistence, or of hydatids, and limited by osseous walls. They are simple (non-parasitic) or parasitic (hydatid).

The majority of the simple cysts are met with in the jaws, and originate in connection with uncut teeth. They are also described in the spongy ends of the long bones—tibia, femur or humerus, and in the vertebræ; it is possible that many of these are nothing more than cystic degeneration of some pre-existing growth, especially such as occurs in enchondromata or sarcomata, and in these cases the cysts are not to be regarded as a separate disease, but merely as an incident in the life history of the solid tumours. When we eliminate these cysts of degeneration and those connected with the jaws, there will remain a very small class of tumours respecting the etiology of which nothing definite is known at present, their origin, although in many instances inflammatory, being often most obscure. The symptoms indicating their presence are very similar to those associated with hydatid cysts in bone, a description of which will be found further on.

Dentigerous or follicular cysts occur in both the upper and lower jaws, as slowly forming, almost painless tumours, and usually connected with the permanent teeth. Either jaw may contain a cyst having a distinct lining membrane, connected with some part of which a tooth will be found. These cysts are formed by the distension of tooth capsules with fluid, which, exercising pressure on the surrounding bone, causes absorption and the formation of a distinct swelling. The limiting wall is generally so thick as to prevent the crackling so characteristic of the presence of fluid in bone cysts. Very often in the upper jaw the cyst is formed by distension of the antrum, and a tooth is situated in some portion of the wall which bounds this cavity.

Billroth¹ is of opinion that in many of the cases usually regarded as "hydrops of the antrum" the cavities are formed in the alveolar process of the upper jaw, and originate close above the sockets of the teeth.

Dentigerous cysts generally contain a clear, serous or a glairy fluid; sometimes it is yellowish or brown from the presence of blood, rarely it contains pus from suppuration of the cyst (Eve).²

In a case mentioned by Paget,³ where Professor Baum removed a tooth from each antrum of a woman thirty-eight years old, "there was distension of the antra, with excessive thickening of the lining membranes and thinning of their osseous walls, and with accumulations of purulent fluid. The disease, which had existed for thirty years and produced terrible deformity of the face, was completely cured by the operation."

Magitôt⁴ arranges follicular cysts under three divisions:—

1. Those that form during the early or embryonic period of the development of a tooth, before the formation of dentine and enamel. 2. Cysts corresponding to a period when the first rudiments of a crown have appeared in the follicle. These he terms odonto-plastic cysts. 3. Cysts of the coronary period, viz., cysts containing fully-developed crowns of teeth, and agreeing with the dentigerous cysts already mentioned.

These three varieties do not exhaust the list of cysts to be met with in the jaws. A brief description of the others must now be made, and for this purpose frequent reference will be made to Mr. Eve's most valuable lecture already quoted.

Multilocular Cystic Tumours of the Jaws.—The affection is more commonly seen in the lower than upper jaw. It commences as a small swelling near the socket of a tooth. When

¹ *Clinical Surgery*. Dent's trans. New Sydenham Society, Lond., 1881, p. 97.

² Erasmus Wilson lecture, on Cystic tumours of the jaw, delivered at College of Surgeons, June, 1882, *British Med. Journal*, Jan. 6th, 1883.

³ *Lectures on Surgical Pathology*, 1870, p. 446.

⁴ *Sur les kystes des mâchoires*.

originating in the lower jaw, the tumour grows within the substance of the bone, distending the compact layer which constitutes a more or less complete capsule around it. On section a multilocular cystic tumour shows an accumulation of cysts divided by partitions of dense fibrous tissue. Partitions are as a rule partially and occasionally entirely ossified. The cysts differ in size. In the ordinary form they are from half an inch to one inch or more in diameter; while in others the cysts are small, and the partitions separating them are ossified. Their contents also vary even in the same growth; they may contain a white, glutinous, colloid material, with a brownish serous fluid, or a reddish friable substance. In the upper jaw the tumour, usually made up of small cysts, with much solid substance, appears in the antrum, distending it and exhibiting the phenomena of a solid growth. The solid portions are found microscopically to consist of branching and irregularly-arranged columns composed of small, round epithelial cells, resembling those in the deeper layers of the epithelium of the gum (Eve).

With regard to the origin of multilocular cystic tumours, they have been known to succeed injuries, irritation of decayed teeth, and long-continued inflammation. Sometimes they have followed an epulis. This form of cystic disease may appear at any age, but usually occurs in early adult and middle life. It exhibits a rounded outline, frequently lobulated on the surface, and bulges more on the outside than on the inner surface of the bone. Its osseous shell may become so thin that pressure causes the peculiar parchment-like crackling, and, when the bone has disappeared, the tumour exhibits a bluish appearance. On exploration a viscid fluid or a brownish matter may be evacuated from different portions of the same growth. The benignity of the multilocular cystic tumours cannot be always guaranteed. The majority of them are innocent, grow slowly, and show all the characters of simple growths. Now and then, however, they recur after

removal, and it would appear from recorded cases that this disposition is most marked when the disease occurs in advanced life. Some rare forms of cysts bearing an analogy to dermoid cysts are sometimes found in connection with the jaws. They may consist of a single cavity containing irregular, ill-formed dentary bodies (Tomes), or made up of two intercommunicating pouches, one having in it a supernumerary tooth bathed in pus, the other containing a yellow fatty matter (Barnes).

Periosteal cysts are small cavities lying beneath the periosteum of the fang, the apex of which is often absorbed. The fluid within these cysts is rich in cholesterine. Tomes regards the process by which these cysts is formed as probably corresponding in the first instance with that which terminates in the production of an alveolar abscess, serous fluid being produced instead of pus, owing to the process being less intense.

In the diagnosis of cystic tumours of the jaws the possibility of mistaking them for solid growths must not be overlooked. An exploratory puncture giving exit to fluid will help to clear up the diagnosis, and assist in determining the plan of treatment to be adopted.

Treatment.—In some cases a cure is effected by puncturing the cyst, evacuating the fluid, and injecting tincture of iodine (Billroth), or by removing the outer wall of the cyst by means of a trephine or by free gouging, and afterwards stuffing the cavity with iodoform gauze and allowing it to granulate. Should a recurrence take place, extirpation of the cyst with the affected portion of the jaw, or complete removal, as in the case of upper jaw, will be deemed necessary.

Cysts in other Bones.—Mr. Erichsen¹ gives a good example of a cyst, containing clear serous fluid, situated in the lower end of the humerus. The disease occurred in a man, aged fifty-three years, who noticed a swelling ten months previously,

¹ *Lancet*, vol. ii., 1856, p. 34.

and had suffered pain for five months. A piece of bone was removed with the trephine and temporary improvement followed. Four months later the trephine was again applied, now a little higher than before. Crown of the instrument readily entered a cavity, and one or two drachms of clear serous fluid resembling synovia escaped. Finger introduced through the opening passed into a round cavity, the walls of which felt smooth, and as if covered with a serous membrane. The patient made a slow but perfect recovery.

Hydatid cysts are rarely encountered in bone; there are probably not more than fifty examples of the disease on record. Its presence often remains unsuspected until spontaneous fracture of the affected bone occurs. Both forms of hydatid—unilocular and multilocular—have been met with; the latter is the more common of the two. The hydatids are found infiltrating the areolæ of the spongy osseous tissue, where at a later period cavities are found, containing a puriform fluid, sequestra, and hydatid cysts. The influence of hydatids on a bone is exercised in two ways, by producing expansion, thinning, and ultimately disappearance of the compact layer, also by causing necrosis from mechanical pressure of the cysts on the lamellæ of the spongy tissue.

Symptoms.—At the onset hydatid disease of bone does not exhibit any external signs of its presence. Later, when the bone is destroyed symptoms appear, which show the extent of the mischief produced by the parasite. Generally, enlargement of a bone is the first symptom which attracts attention. If the bone yields at one part, parchment-like crepitation may be present. At a more advanced stage, owing to the multiplication of the hydatids and the formation of purulent collections, swellings are produced, which disclose a lesion that up to then had remained latent. The purulent collections are often multilocular, and the fluid can be detected passing from one cavity to the other. Sometimes, by pressing on the swelling,

the larger portion of it can be made to disappear. This has been observed in hydatid disease of the tibia. Hydatid fremitus, often so characteristic of the disease when attacking the liver, is absent in most cases of bone hydatid. Once the affection has travelled outside the bone, it exhibits a rapid progress, and passes in the direction where it meets with least resistance. As a general rule, the general health of those suffering from hydatid disease of bone does not suffer; occasionally, however, from pressure of the cysts on important structures, such as large nerve trunks, great suffering is experienced, and a corresponding deterioration in the health. The course of the affection is generally slow and progressive. Occasionally it is so rapid that a fatal issue takes place within twelve months (Wilks and Moxon); while in others an interval of fifteen years has elapsed between the onset of the disease, as indicated by more or less persistent pains, and the appearance of any swelling.

In fifty cases given in full by Gangolphe¹ four were examples of the disease occurring in the head, seven in the spine, one in the ribs, one in the sternum, eleven in the pelvis, and the remaining twenty-six cases in the bones of the extremities. In the limbs the disease is characterised by localised swelling, with an indolent and slow course, and the absence of local and general reaction. There is, however, one complication which may be regarded as altogether special, viz., spontaneous fracture. The bone thins and eventually gives way under the influence of some slight cause. Spontaneous fracture has been observed in the humerus, femur, and tibia with an almost equal frequency; also once each in the acetabulum and the dorsal spine.

Diagnosis.—The only certain indication of the presence of hydatid disease in bone is the discovery of the cysts. An exploratory puncture may be permissible with the view to

¹ Kystes hydatiques des os. Thèse de Paris, 1886. This work contains a good bibliographic index.

making a diagnosis and to determine the requisite treatment. It is possible to mistake a hydatid cyst for a sarcomatous growth, especially when the disease attacks the pelvis. We should always remember the indolent, slow character of the hydatid affection. In a case published by Hilton¹ the sarcomatous and non-parasitic nature of a cystic growth which had induced a fracture of the thigh was determined only after a microscopical examination. The hydatid disease will also have to be discriminated from the tubercular forms of osteitis. The appearance of a large, cold abscess, originating in the parasitic disease, will suggest a tubercular bone affection. A differential diagnosis in most cases can only be made by a puncture or an exploratory incision, and examining the contents of the cavity. In some cases even this has been insufficient, and the nature of the disease has been undecided until a post-mortem examination revealed its true character. To sum up the whole matter in regard to the diagnosis, a puncture or even an incision is generally needful before a diagnosis of hydatid disease can be made with any degree of certainty.

Prognosis.—The prognosis will largely depend on the seat of the disease, being less grave when attacking the limbs; but here life can be preserved in many cases only by sacrificing the member. A considerable number of cases die from septic complications due to the introduction of germs into the hydatid abscesses. Hydatid disease of the spine is peculiarly fatal, so far six out of seven cases ending in death.

Treatment.—The only efficacious plan of treatment is to open the cyst and remove its contents, at the same time carefully guarding against every possible source of septic contamination, which has terminated so disastrously in so many cases. To successfully exterminate hydatids invading a bone is not by any means an easy matter in all cases. A free opening will be necessary; this, combined with due caution in exploring

¹ *Lancet*, 1855, vol. i., p. 65.

every portion of the hydatid cavity, will often succeed. After removal of the cysts with any disintegrated bone by means of a spoon, the cavity must be thoroughly cleaned with an antiseptic fluid, and carefully drained. In many cases the hydatid disease will have produced so much destruction of bone, or possibly invaded a joint, as to necessitate amputation. It is very doubtful whether resection will be sufficient when the articular ends are invaded with hydatids, the diaphyses in most cases being involved at the same time. In a case reported by Hahn,¹ where the disease attacked the opposing surfaces of the tibia and femur, it was found after amputation of the thigh that, although the hydatids were confined to the articular extremity of the femur, they had already invaded the medullary canal of the tibia (*fig.* 58). If a resection had been performed, the disease of the shaft of the tibia would have remained untouched, and necessitated a further operation.

When a spontaneous fracture occurs, the treatment will vary with the extent of the disease. Whenever practicable, the portion of bone affected should be removed, and the freshened osseous surfaces brought together with silver sutures. By this method cases have been treated by Dupuytren, Küster, and others. Dupuytren² operated on a humerus, which was the seat of pseudarthrosis. The upper fragment was easily exposed, and a portion of it resected. When denuding the upper end of the lower fragment, he was astonished to find a cavity full of hydatids. These were dislodged, and the two fragments approximated without removing any portion of the lower one. For several days afterwards hydatids issued by the wound. There was abundant suppuration, diarrhoea, loss of strength, and death six weeks after the operation. Subsequent examination showed that the medullary cavity of both fragments was filled with pus, and hydatids were found in the muscles of the arm.

¹ *Berliner klinische Wochenschrift*, No. 6, 1884, p. 81.

² *Journal Univ. et Hebdom. de Méd. et de Chir.*, 1832, vol. ix., p. 446; also 1833, vol. xii., p. 97.

In Küster's case¹ the disease also existed in the humerus, which was fractured nine weeks before he came under observation, and there had been no attempt at union. An incision, made to introduce hooks into the bone, evacuated a sero-purulent fluid, and a bone abscess was diagnosed. Two days later other incisions became necessary, and now some whitish substance escaped, which was recognised as a part of a hydatid cyst. For some time the suppuration was abundant, and accompanied with the discharge of hydatids. Then there was a marked improvement and every prospect of a good result, when the patient was seized with erysipelas. The elbow and shoulder joints became involved in a suppurative inflammation, and at last amputation at the shoulder joint had to be performed. A rapid cure followed.

Wickham² records a case of hydatid disease in the tibia, followed by fracture.

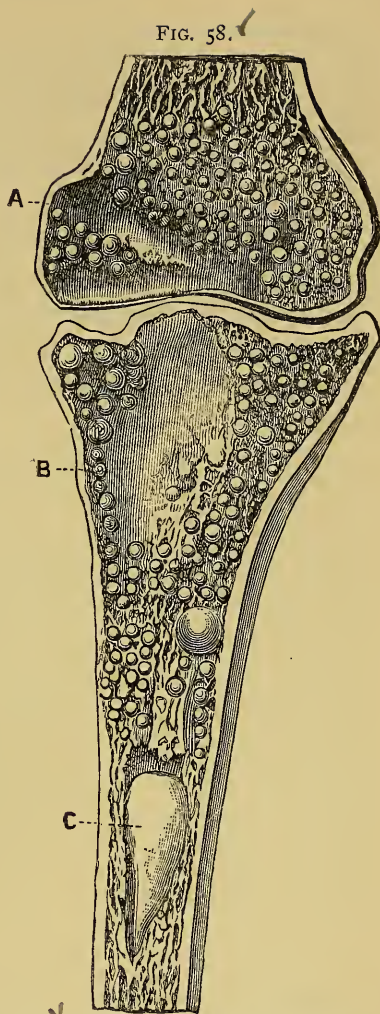


FIG. 58.—A. Lower end of femur infiltrated with small cysts, internal condyle excavated and containing a sequestrum. B. Upper end of tibia, also infiltrated with cysts and presenting a cavity similar to that in the femur. C. Large hydatid cyst in medullary canal (after Hahn, taken from Gangolphe).

¹ *Berliner klinische Wochenschrift*, 1870, No. 12, p. 145.

² *London Medical and Physical Journal*, 1827, vol. lviii., p. 530.

As there was no union after fourteen weeks an incision was made and a number of hydatids escaped. An irregular fracture of the bone discovered, and the extremity of each fragment for about an inch in extent consisted of a very thin osseous shell. Nearly four inches of the anterior surface was resected, and a cure followed.

Hydatid disease affecting the skull is rarely amenable to treatment. Exception must be made of those rare instances where the affection originates in the frontal sinus, as in a case mentioned by Keate¹ in which a cure was produced.

The following² is one of the latest reported cases of hydatid disease of bone:—

HYDATID DISEASE OF THE FEMUR.—REPORT OF A CASE READ BY DR. COPPINGER BEFORE THE PATHOLOGICAL SECTION OF THE ACADEMY OF MEDICINE IN IRELAND.

Case 33.—The patient had been under observation for three years, having been admitted to the Mater Misericordiæ Hospital on receipt of a spontaneous fracture of the upper third of the femur, due apparently to its invasion by the parasite. The disease was not diagnosed until Mr. Coppinger had made an attempt to excise the patient's hip joint, and discovered a large cavity in the dilated upper part of the femur containing hydatid cysts and loose pieces of bone studded over with small echinococcus vesicles. The complicated excision was abandoned; but the great trochanter was removed with a saw, and the cavity finally laid open and syringed out. The patient's condition was not satisfactory after the treatment had extended over two years; the wound remained open, and a sinus led upwards into the femoral head and downwards into the shaft of the bone. Shreds of membrane and collapsed cysts continued to escape, and there was every appearance that the disease had not been eradicated. This case appears to be the first recorded instance of hydatid disease of bone in Ireland.

OSTEO-ANEURISM, OR PULSATING TUMOUR OF BONE.

There is every reason to believe that the majority of tumours formerly regarded as aneurisms of bone belong to the group of malignant osseous growths, and that the number of those in which no morbid tissue is discovered constitutes an exceedingly small class. Of the seven cases of pulsa-

¹ *Medico-Chir. Transactions*, vol. x.

² *British Med. Journal*, vol. i., 1883, p. 1070.

ting tumour of bone that have come under my observation six proved on examination to be of a sarcomatous character, while in the remaining case a small pulsating growth appeared on the shaft of the tibia as a secondary manifestation of cancer, following an atrophic scirrhous of the breast. Still competent authorities speak of a special vascular tumour, which Volkmann distinguishes by the name hæmatoma of bone. It consists of a cavity containing fluid or clotted blood, and surrounded by a capsule of fibrous tissue or of fibrous tissue and bone; blood-vessels, which permeate its walls, open into it. These tumours are usually near the epiphyses of long bones, especially in the vicinity of the knee joint and in the upper end of the humerus. They never invade the neighbouring soft structures, but merely displace them as they increase in size. They are not to be regarded as cavernous angiomas, nor as aneurisms of the bone arteries; and the absence of actively growing structures excludes the theory of a degenerated malignant growth. Volkmann, however, thinks that the primary morbid tissue may have been destroyed by the outpouring of blood, and that the search for it giving negative results is not conclusive of the non-malignant nature of the tumour. Another theory regards aneurisms of bone as due to the rupture of a healthy or diseased artery, with the formation of a cavity which increases by destruction of the surrounding structures.

Symptoms.—Osteo-aneurism possesses features closely resembling an ordinary aneurism. With each systole there is an expansile pulsation which ceases when the main artery of the limb is compressed, while at the same time there is a diminution in the size of the tumour, which may partly disappear, displaying a cavity with osseous walls (Schwartz). Besides these symptoms, there is usually a systolic bruit of a very distinct character.

Diagnosis and Prognosis.—It will be almost impossible to discriminate between new growths that pulsate and true osteo-

aneurism. If the tumour is reducible and all pulsation in it ceases as soon as we compress it, to reappear when the compression is removed, if the general health of the patient is good, and if the tumour occupies any of the situations before mentioned, it is permissible to regard it as an aneurism of bone (Schwartz). As a rule no difficulty is experienced in distinguishing a pulsatile tumour of bone from an ordinary aneurism, the position of the former being generally sufficient for the purpose. When, however, the disease occupies the inner extremity of the clavicle, it may become an impossibility to tell it from an aneurism of the subclavian pushing forward and expanding the bone. In those cases where an osteo-aneurism does not pulsate, it will be a difficult matter to diagnose it from the benign bony tumours; an exploratory puncture will afford some information. In consequence of the almost insuperable obstacles attending the differential diagnosis of pulsatory growths of bone, we cannot do otherwise than regard the prognosis as unfavourable.

Treatment.—Did we possess the means of determining the correct nature of any pulsatile tumour of bone, no doubt the proper course to pursue in the true osteo-aneurism would be compression or ligature of the main vessel, which has been successfully carried out in a small number of cases (Lagout). In those rare cases of erectile growths found in the skull and scapula a cure has been sometimes effected by securing the supplying vessels. . Amputation, or in exceptional cases resection, is the essential mode of dealing with pulsatile malignant growths springing from bone.

CHAPTER XV.

MALIGNANT TUMOURS OF BONE.

The opinion now prevails that most, if not all, the primary malignant growths met with in the osseous system are to be included in the class of sarcomas,¹ while the carcinomata mainly occur as secondary growths.

Of the sarcomas—tumours made up of embryonic cells and belonging to the connective-tissue series—there are several distinct varieties, each distinguished by the size and shape of its predominant cellular components:—thus, we have the round-celled, spindle-celled, myeloid or giant-celled, and the mixed-celled varieties. The round and spindle forms are further subdivided into the large celled and small celled, and this is not a fanciful separation, for the size of the cells of which a tumour is composed has an important influence on its consistence and prognosis.

1. *Round-celled Sarcoma.* Syn. *Encephaloid sarcoma*, *Meddullary sarcoma* (Virchow), *Embryo-plastic tumour* (Lebert).—This form of sarcoma is made up of small cellular elements; generally round, separated, and at the same time united by a soft, homogeneous, or finely granular substance; freely supplied with vessels, the walls of which are thin, and formed by a single row of spindle cells. This variety of sarcoma is com-

¹ Out of two hundred cases, Schwartz, *Ostéosarcomes des membres*, found the lower extremity attacked one hundred and fifty-five times, and the upper forty-five.

mon in bone, where it may grow rapidly, and assume large proportions. Its vascularity may be very pronounced, leading to the production of symptoms often erroneously attributed to aneurism of bone. The tumour is often the seat of hæmorrhages, and may undergo mucoid degeneration with the formation of cystoid cavities.

2. *Spindle-celled Sarcoma.* *Syn. Fasciculated sarcoma (Cornil and Ranvier), Fibro-plastic tumour (Lebert), Fusio-cellular (Virchow).*—This variety, more common in bone than the former, is formed of a large number of fusiform, oval, spindle, and oat-shaped cells, arranged in fasciculi, which freely inosculate and intertwine. In firmness it varies much; the hard, spindle-celled form of tumour frequently springs from the outside of the bone; while the softer variety, in which there is an admixture of round and spindle cells, originates in the interior.

3. *Myeloid or Giant-celled Sarcoma.*—In this form of sarcoma large polynucleated cells, resembling those of foetal medulla of bone, are encountered in considerable numbers. Besides these, the tumour also contains round and spindle cells, similar to those already described. Giant or myeloid cells are not peculiar to any one form of sarcoma nor indeed to sarcomas at all, but are met with in far larger quantities and in a much more perfect state in the variety we are now considering. A morbid growth does not acquire the title of myeloid, unless it presents a large proportion of giant cells, and has a dark red or maroon colour.

4. *Mixed-celled Sarcoma.* *Syn. Sarcoma mixtum (Rindfleisch).*—When a morbid growth consists of round, spindle, and giant cells in varying proportions, together with cells less uniform in shape, it is placed in a separate class of mixed-celled sarcoma (Butlin).

All the foregoing varieties of sarcoma are liable to degenerations which considerably modify the appearances of the original growth. Among these chondrification, calcification

(fig. 59), and ossification (fig. 60) are the most striking and important. Fatty and caseous changes are also observed. Mucoid softening, with the formation of cystoid cavities (fig. 61), is frequent in some of the large, mixed-celled sarcomas; while colloid transformation similar to that witnessed

FIG. 59.



FIG. 59.—Calcifying tumour surrounding upper end of tibia, involving knee joint (*O. C. Museum*).

in carcinomas has been described in at least one case of multiple malignant tumour of bone.¹ Telangiectatic degeneration,

¹ Moxon, *Trans. Path. Soc.*, London, vol. xxii., p. 206.

resulting in the production of a spongy, vascular tissue, with symptoms simulating aneurism, is most often seen in connection with the tumours arising within a bone.

FIG. 60. ✓



FIG. 60. — Ossifying subperiosteal sarcoma; lower end of shaft of femur (*O. C. Museum*).

Bone sarcomas may be primary or secondary¹ (*fig. 62*), and originate either in the deeper layer of the periosteum, when they are termed subperiosteal, peripheric, or periosteous, or arise within the bone itself, where they have been called central, intra-osseous, endosteal, myelogenic, or myeloid sarcomas. They² very frequently present naked-eye appearances which are fairly characteristic. The yellowish red or maroon colouration of a giant-celled tumour, the grayish white, glistening surface of a spindle-celled growth, and the brain-like appearance of a round-celled tumour may be given as examples.

Parosteal sarcomas³ originate in the tissues outside and bordering on the periosteum, implicating the latter and the bone secondarily. Although these sarcomas are closely attached

¹ They may be secondary to a sarcoma of the soft parts, or of some other part of the skeleton.

² Their distribution in the long bones corresponds very nearly with that of acute osteomyelitis, attacking those parts of the osseous system where growth is most active.

³ Butlin, *Lancet*, 1883, vol. ii., p. 227.



to the bone from which they appear to arise, a more minute examination will disclose little or no implication of the bone, while the surrounding tissues are seriously involved. Carrera¹ regards parosteal growths as tumours springing from the external layers of the periosteum, the peri-osseous sarcomas arising in the deeper layers of the same membrane.

FIG. 61.✓



FIG. 61.—Central cystic sarcoma; lower end of femur.

Subperiosteal sarcomas (*plate iii.*) are situated between the periosteum and bone, separating them from each other. If they increase in size rapidly, the fibrous capsule formed by the outer layer of the periosteum, which usually limits the growth, may disappear, the tumour invading the intermuscular

¹ *Essai sur les tumeurs fibro-plastiques des os*, Thèse de Paris, 1865.

spaces, where it not infrequently forms isolated masses. The peripheral sarcomas may also penetrate the cortical layer of the bone on which they are seated, but generally only to a limited extent; in some rare cases they extend through the bone, and invade the medullary canal. They are composed of all the varieties of cells already mentioned, the spindle cells, however, largely predominating. They manifest a remarkable tendency to calcification and ossification, and many,

FIG. 62.

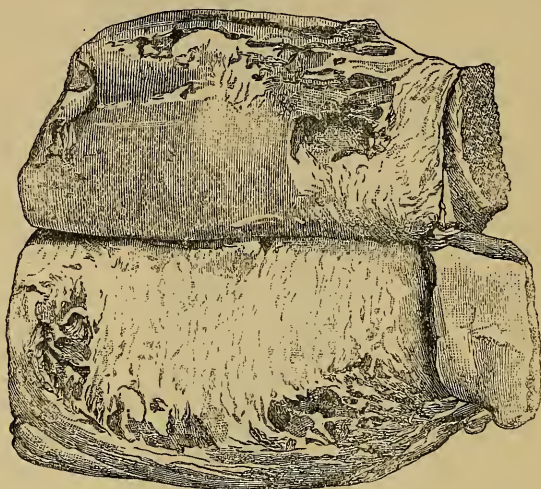


FIG. 62.—Round-celled sarcoma of rib, secondary to a similar tumour of upper jaw (*O. C. Museum*).

of the growths formerly classed as osteoid cancers must be regarded as peripheric ossifying sarcomas. The bone tissue may be present in the form of small islets, or it may form needles or a trabecular structure, permeating the morbid mass, and exhibiting an arborescent appearance after maceration. Osseous tissue is never found in the investing membrane, so that the presence or absence of bone in the capsule is of great value in the determination of the original site of the new growth.¹

¹ Gross, *American J. of Medical Sciences*, July, 1879, p. 18.

Central, or intra-osseous sarcomas (*figs. 63, 64, 65, 66*), have their origin in the interior of a bone, and spring from the marrow of the cancellous tissue, often from that in the articular ends of long bones. The most common form is the giant-

FIG. 63.

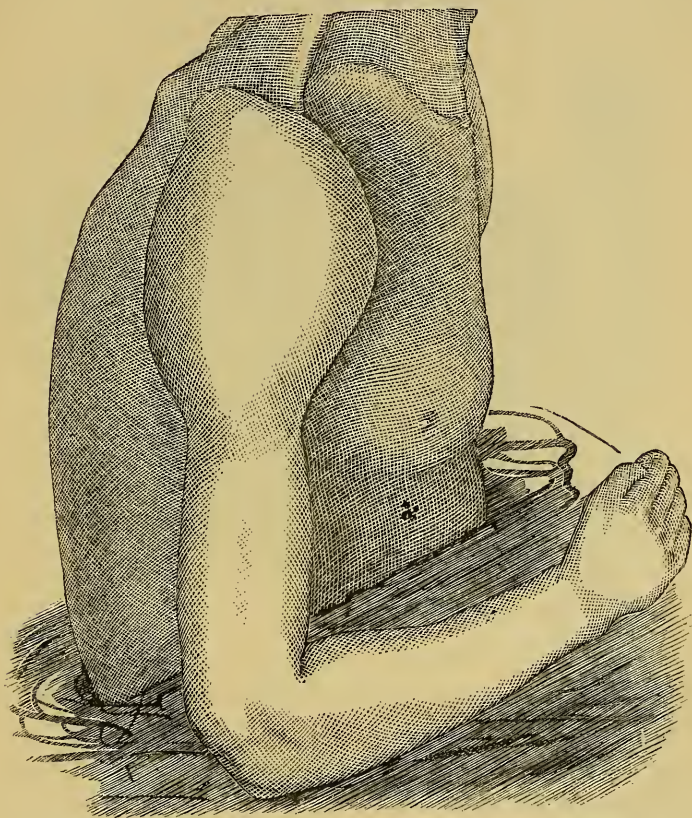


FIG. 63.—Spontaneous fracture of the humerus, F. 43; central sarcoma (?); treatment refused (*Mr. Southam's case*).

celled, so frequently met with in the jaws, most commonly the lower, where it constitutes one form of epulis (épulide intra-osseuse of Nélaton). The central tumours are bounded by an osseous capsule, which is destroyed as they increase in size, to

be replaced by bone formed from the periosteum. As a rule, less bone is produced than is removed by absorption, so that the casing after a time becomes deficient, and the growth perforates its shell. Central growths destroy the bone from within outwards, while in the subperiosteal varieties any destruction of the bone that may occur commences on the surface.

FIG. 64.

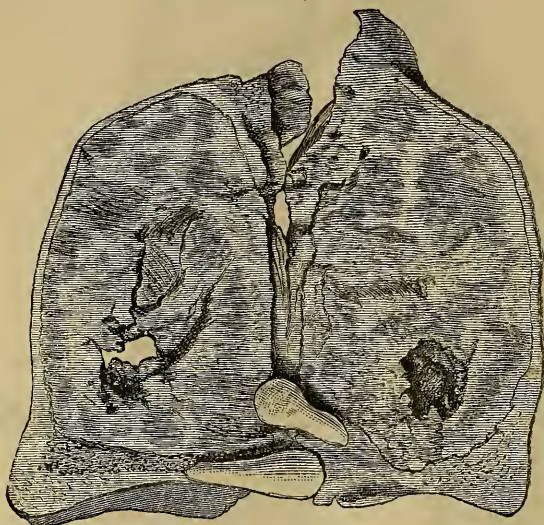


FIG. 64.—Central tumour lower jaw; myeloid sarcoma (*O. C. Museum*).

Another form of intra-osseous growth, peculiarly prone to attack the lower end of the femur, upper end of the tibia, and the head of the humerus, is a compound tumour of the mixed-celled variety. It is very soft and vascular; its fragile vessels easily give way, producing extravasations of blood, and leading to a suspicion of aneurism of bone.

Central sarcomas possess certain clinical features which serve to distinguish them from the subperiosteal tumours. In shape, whether they originate in the epiphyses,¹ which is

¹ The epiphyses and articular ends of the long bones are attacked nearly five times as often as the diaphyses.

usually the case, or in the diaphyses, they assume a more or less spherical outline. Their surface is generally smooth, sometimes irregular, and even moderately lobed. Their rate of growth is decidedly slower than that of the subperiosteal variety, and the age at which they develop is more advanced.

FIG. 65.✓

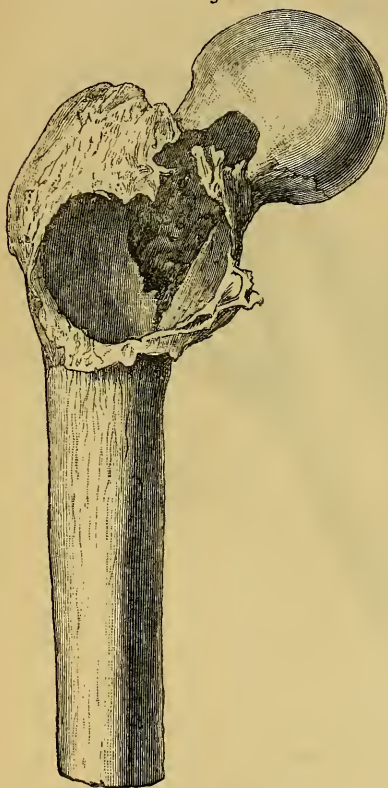


FIG. 65.—Central sarcoma, upper end of femur, bone expanded into a thin shell (*O. C. Museum*).

FIG. 66.✓

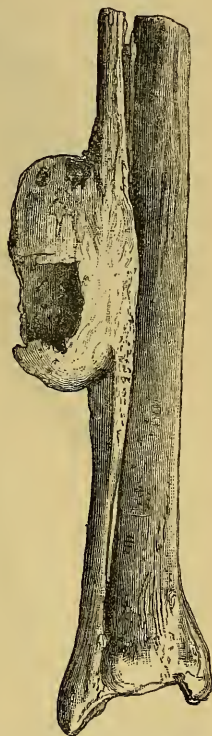


FIG. 66.—Central sarcoma of fibula (*O. C. Museum*).

Central growths are less malignant than the subperiosteal, and among them that variety composed of giant cells exhibits this property in the least marked manner; and this, no doubt, is largely due to the slight tendency which the central tumours generally exhibit to pass beyond their osseous boundaries. In

be replaced by bone formed from the periosteum. As a rule, less bone is produced than is removed by absorption, so that the casing after a time becomes deficient, and the growth perforates its shell. Central growths destroy the bone from within outwards, while in the subperiosteal varieties any destruction of the bone that may occur commences on the surface.

FIG. 64.

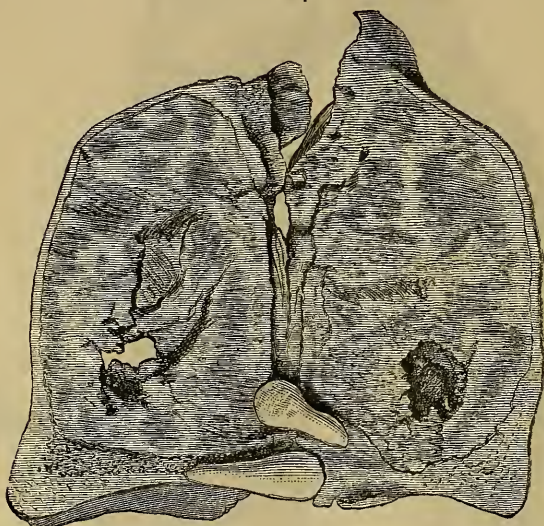


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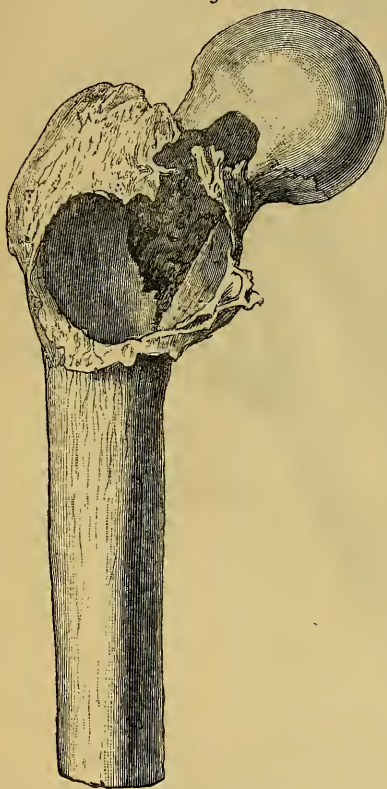


FIG. 65.—Central sarcoma, upper end of femur, bone expanded into a thin shell (*O. C. Museum*).

FIG. 66.✓

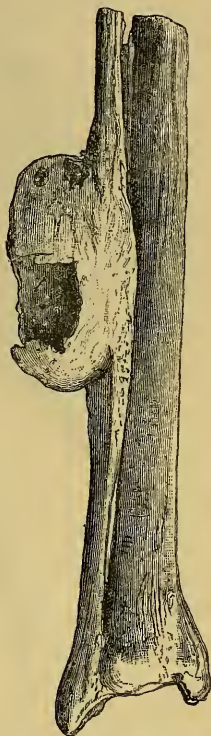


FIG. 66.—Central sarcoma of fibula (*O. C. Museum*).

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common with the subperiosteal tumours, central growths may possess the peculiar property of pulsation; but this symptom is witnessed much more commonly in those tumours which grow in the interior of a bone, rarely in the subperiosteal forms.

FIG. 67.

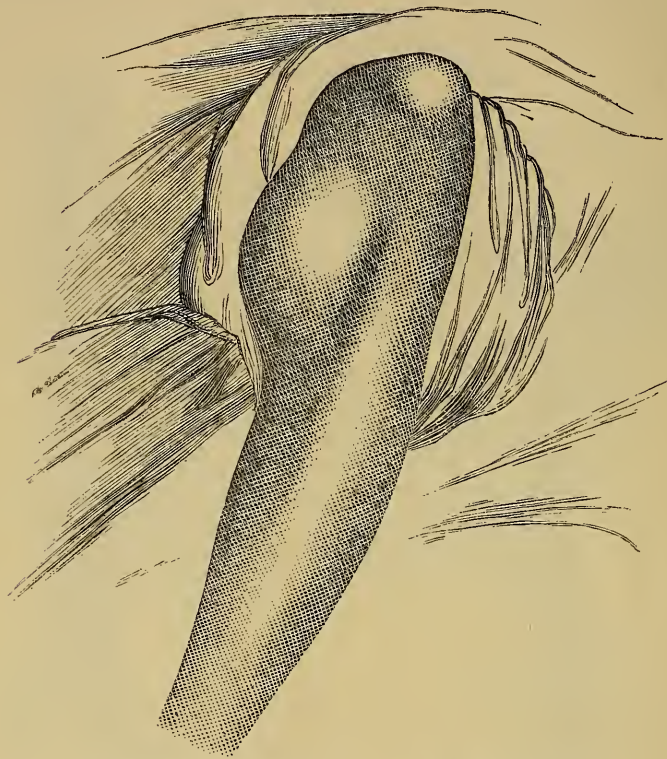


FIG. 67.—Pulsating myeloid, in head of tibia. Case 34 (see *plate iv.*).

PULSATING MYELOID, HEAD OF TIBIA; AMPUTATION THROUGH THE THIGH;
RECOVERY.

Case 34.—Emily C., aged twenty-three, admitted March 16th, 1886. Patient is emaciated, and has an unhealthy appearance, although she has suffered from no previous illness. No history of cancer in the family. She attributes the swelling on her leg to a slight blow she received eighteen months ago. It grew very slowly for twelve months, but, receiving another blow in the same situation, the swelling increased rapidly until admission, when there was a tumour, the size of a tangerine orange, just below the inner tuberosity of the left tibia (*fig. 67*). It is circumscribed and of uneven consistence, and pulsates distinctly; the tibial pulse on the



left side is much weaker than that on the right. The skin is normal and moves freely over the tumour; subcutaneous veins slightly enlarged. The swelling is not painful, but rather tender on pressure, and egg-shell crackling can be felt over a small area in the centre. There is no glandular enlargement. The limb is in a semi-flexed position, but the knee-joint is unaffected. Percussion and auscultation revealed no evidences of disease in the chest. Urine normal. The thigh was amputated at the junction of middle and lower thirds by a long anterior skin flap, made by cutting from without inwards, and a short posterior mixed flap by transfixion; the femoral was torsioned and the smaller vessels tied. The edges of the flaps were brought together by numerous silk sutures; two glass drainage tubes inserted, and brought out through the dressings. The antiseptic employed during the operation was sublimate solution (1 in 2,000), and the stump was dressed with iodol and wood-wool pads. She made a good recovery as far as the wound was concerned, the whole of it uniting without any suppuration, but she suffered from the effects of mercurial absorption, a troublesome stomatitis appearing on the third day after the operation, and continuing for several months. Dr. Chambers, of Denton, who was kind enough to send me this case, writes under date March, 1887, that the patient is in very good health, the stump is sound, and there is no appearance of any recurrence in any part of the body.

Sarcomas connected with the outside of a bone are to be discriminated from those originating in the interior by:¹

- i. Their relative infrequency (seventy-seven periosteal to one hundred and twenty-eight central—Schwartz);
- ii. Their occurrence earlier in life;
- iii. Their marked malignancy and tendency to generalisation;
- iv. Their more frequent implication of glands;
- v. The excessive suffering which they occasion;
- vi. Their much greater disposition to calcareous and osseous transformations;
- vii. Their not being contained in bony capsules;
- viii. Their less liability to telangiectatic degenerations and to extensive effusions of blood;
- ix. Their attacking by preference the diaphyses, or the junction of diaphyses with epiphyses;
- x. Their little tendency to invasion of joints² (one in twelve, central one in five), to pulsation, and to fracture from slight causes.

¹ Chiefly after Gross, *loc. cit.*

² Periosteal sarcomas may extend from one bone to another, along the fibro-synovial structures, without implicating the intervening articulation.

Spontaneous fracture or fracture from slight causes is not unfrequently seen in the central growths, rarely in the subperiosteal forms (*plate 9*). The malignancy of bone sarcomas may be exhibited in different ways; either by the continuous infiltration of neighbouring structures, not unfrequently seen in the subperiosteal forms, or in the implication of associated lymphatic glands (very rare), or by dissemination and reproduction in distant and internal organs, especially the lungs; the secondary growth possesses characters similar to the original neoplasm. Sarcomas of bone arranged in their order of malignity may be thus arranged, being designated from their predominant constituent: periosteal spindle cells, periosteal round cells, central round cells, central spindle cells, central giant cells (Gross).

Sarcomas of bone have to be diagnosed from: 1. Innocent bony tumours. 2. Other diseases (white swelling, chronic inflammatory affections of bone and periosteum, aneurisms).

1. *From innocent bony tumours*, by their history, greater frequency, quicker growth, painfulness, and unequal density.

2. *Other Diseases.*

(a) *White swelling*,¹ more particularly of the knee, may be mistaken for a sarcoma, originating in the articular extremities or beneath the periosteum of the femur or tibia. An error in diagnosis occurred in the case of a man, twenty-eight years, a patient at the Infirmary about four years ago. The growth was so placed that it completely enveloped the lower end of the femur, immediately above the synovial sac. Notwithstanding rest and the treatment usually adopted in chronic joint diseases, the tumour steadily increased, and its course was marked throughout by much suffering, especially when any compression was exercised. I must confess that up to the

¹ See in this connection two very valuable papers: Gillette, *Bull. de la Soc. de Chir.*, t. ii., 1876, p. 127; Eames, *Boston Medical and Surgical Journal*, 1859, vol. lix., p. 452; also Poinsot, *Études cliniques sur l'ostéo-sarcome des membres*, Paris, 1877.

time of the exploration, before amputating this man's thigh, I had not made up my mind whether he was suffering from knee-joint disease or a growth springing from the femur. An incision cleared up the difficulty, and led to amputation in the upper third of the thigh, which was successful in so far that it removed all suffering, and prolonged life for eighteen months, the patient then dying from dissemination of the disease to the lungs. The points likely to aid us in distinguishing the two affections are the following: the steady and often rapid increase in the size of the sarcomatous tumour, which is often more prominent on one side of the joint than the other. The movements of the articulation in bone sarcoma, although in some instances limited, are usually painless. Throughout, the general health of the individual affected with sarcoma may remain undisturbed.¹ In white swelling, when the pain becomes so severe as to deprive the patient of rest, there soon occurs an impairment of the health. This, combined with stiffness of the articulation and increase of suffering when any attempt is made to move it, together with a tendency to suppuration and the production of a flexed, improper position, will assist in the diagnosis. Again, white swellings do not pulsate, and pressure never produces egg-shell crepitation.

(b) *Sub-acute Articular Osteitis*.—The mistake will generally arise in connection with central growths, especially those of the femur and tibia. Generally the inflammatory affection is attended with marked febrile disturbance and more alteration in the state of the health. Again, when the disease approaches the surface, the soft parts become swollen, and suppuration often occurs. Furthermore, the pain has the peculiar characteristics already alluded to in the chapter on osteomyelitis. In case of doubt, the proper plan would be to explore and deal with the case in accordance with what we discover. The escape of blood only, goes far in favour of a new growth.

¹ When the growth commences to progress rapidly, it usually produces marked emaciation.

(c) *Chronic Inflammation of Bone*.—Chronic inflammation, particularly when deep seated in the bone itself, is often with difficulty diagnosed from a central sarcoma. The inflammatory symptoms scarcely exist in many of those cases of central necrosis without suppuration, to which attention has been specially called by Sir James Paget and others, in which the errors generally occur. There are, however, certain points,¹ attention to which will greatly diminish the chances of mistake; these are in a tabular form the following: 1. Necrosis occurs in the diaphysis (of femur), and generally in the middle portion of bone. 2. The swelling produced by new bone feels firm or hard, and generally is smooth and fusiform. 3. The increase of the tumour has not been rapid and continuous. 4. Malignant (central) tumours are rare in the shaft. 5. The consistence of those which do affect the shaft is generally very soft, almost fluctuating, or very unequal. 6. Increase of tumour is invariably rapid and continuous.

(d) *Chronic Periostitis (Simple or Syphilitic)*.—The shape, position, and history of the swelling are of importance; also its consistence, which in sarcomatous growths is often unequal, soft, and elastic. Too much reliance must not be placed on an increase in the local temperature² as indicative of an inflammatory affection, as some subperiosteal and central tumours when they grow rapidly are attended with a considerable degree of local heat, and even the constitutional indications of inflammation.³ The case must be carefully watched, and measurements taken in order to determine whether the swelling is increasing or not. Some clue to the nature of the tumour may also be obtained by observing the effects of treatment,—of iodide of potassium, when a suspicion exists that its appearance is in any way connected with

¹ Butlin, *Sarcoma and Carcinoma*, London, 1882, p. 72.

² The valuable observations of Estlander on this point in the *Revue Mensuelle*, 1878, p. 95, afford some important information.

³ MacCormac, *British Medical Journal*, 1879, vol. i., p. 87; also Guéneau de Mussy, *Bull. de la Soc. Anat.*, 1842, p. 119.

syphilis. In the end, very frequently doubts concerning the character of a bony enlargement can be effectually dissipated only by making an exploratory puncture or an incision into it, and the adoption of this simple expedient should not be delayed too long, otherwise the chances afforded by early amputation in case of a sarcoma will have been lost.

(e) *Aneurism of Bone*.—It is doubtful whether such a condition exists apart from the sarcomas. In most of the pulsating sarcomas the bruit, if any, is very indistinct, and the pulsation does not usually appear until the disease has existed for some time, and its appearance often coincides with a rapid increase in the size of the growth.

(f) *Ordinary Aneurism*.—This disease is certainly rare before thirty, while two-thirds of the pulsating sarcomas occur before that age (Gross). The situation of the pulsating tumour is also of paramount importance, the majority springing from positions some distance from the line of a large vessel (internal condyle of femur, inner tuberosity of tibia, upper epiphysis of fibula). Very great difficulties are occasionally encountered in the diagnosis of pulsating swellings connected with the pelvis; these will be mentioned again later on. Generally speaking, the presence of a bone tumour has been noticed for some time before any pulsation occurs in it.

MYELOID TUMOURS OF BONE.

Syn. MYELO-PLAXIE (NÉLATON); GIANT-CELLED SARCOMA (VIRCHOW).

Myeloid tumours generally spring from the interior of bones, and possess many points of interest. Histologically they must be included in the sarcomatous class, to which also belong some of the most malignant tumours of bone. Clinically, however, the myeloid growths are often regarded as benign, for they exhibit little tendency to return after complete removal. The tumours to which Paget¹ gave the name of

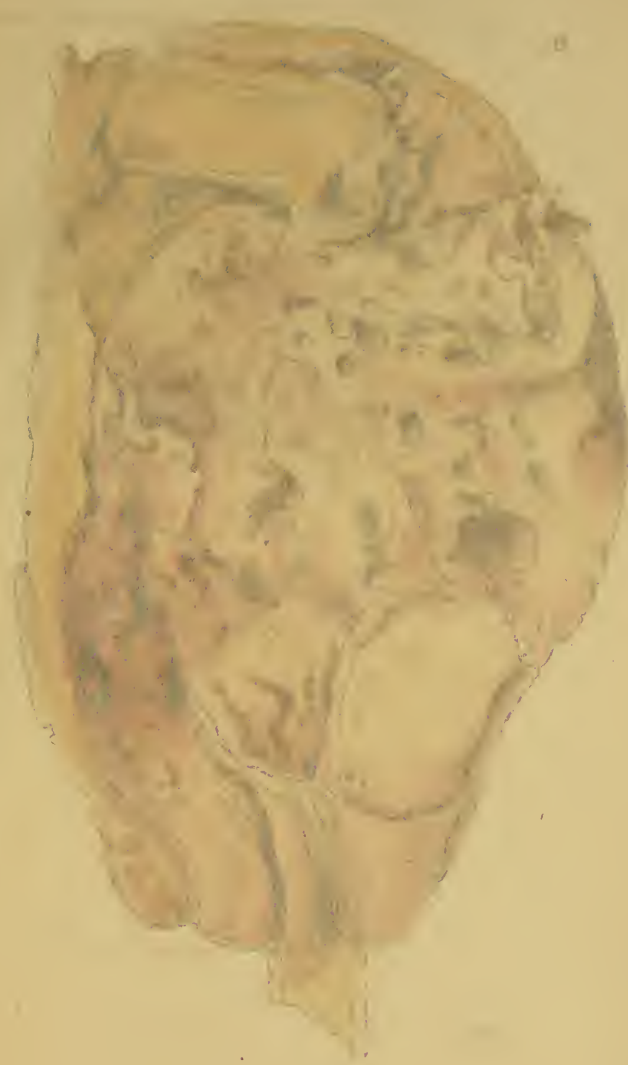
¹ *Lectures on Surgical Pathology*, 1870, p. 544.

myeloid were first distinguished as a separate kind by Lebert, who discovered the peculiar polynucleated cells in an epulis. They are composed of medulla elements, with a large admixture of giant cells (polynucleated, myeloid cells, myelo-plaxes). These latter are by no means confined to the growths we are now considering, but are found in them in larger proportion and more constantly than in any other structure. This peculiarity, combined with the characteristic maroon colour, serves to distinguish myeloid from other tumours of bone.

They are found in connection with the upper and lower jaws, where the name epulis is given to them, as also to the fibromata arising in the same situations. In addition, they attack the long bones—tibia, femur, fibula; also, but much more rarely, the humerus and radius at the level of their epiphyses. These tumours vary considerably in size; sometimes attaining large proportions. Their consistence also varies; they are either hard as a whole or only in parts, or they constitute soft masses which may be even fluid in certain situations. They are generally met with in the young, very rarely after middle life; as a rule grow slowly, and are often destitute of pain. They may either begin in the centre of the bone (central or intra-osseous), which is usually the case, or they may grow beneath the periosteum (subperiosteal¹ or peri-osseous). They consist of round, transparent medulla cells, or of many nucleated clear or dimly-granular masses—generally of these two constituent elements in different proportions—to which, especially in the peri-osseous forms, must be added fusiform cells and fully-formed fibres.

The subperiosteal forms possess a great tendency to calcification or ossification, hence they are sometimes designated ossifying sarcomas—one form of osteoid cancer. The osseous substance presents itself generally in the form of fine trabecular

¹ In the periosteal form the myelo-plaxes are not the essential elements.



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network, or as needles, which, commencing in that portion of the tumour in contact with the bone, spread through the entire mass (Schwartz).

The myeloid tumours that arise in the centre of the bone are much more frequent than the subperiosteal variety, grow from the marrow either of the epiphyses or the diaphyses, generally the former. They are made up of large, round or oval cells, intermingled with which are to be found a large number of polynucleated cells, resembling those of foetal marrow, and a sparing amount of fusiform cells and fibres. As they increase in size they produce thinning and absorption of the bone until a shell alone remains, which gives a parchment crepitation. Sometimes the growth is disseminated through the areolæ of the spongy tissue, when the bony structure may be entirely replaced by the morbid mass without any expansion of the bone invaded.¹ The mass assumes a peculiar cavernous arrangement, which, combined with its abundant vascularisation, causes it to be designated aneurismal tumour of bone. In a case of myeloid growth, springing from the internal condyle of the femur, the pulsation so closely resembled that connected with an ordinary aneurism as to lead many strongly to suspect the latter disease. There was also a marked systolic bruit present. The position of the tumour and its bony relations effectually dissipated the idea of popliteal aneurism. After removal of the limb, the growth on section presented a spongy, deep-red appearance, and microscopical examination revealed a myeloid structure.

The naked-eye appearances of a myeloid growth will vary somewhat with its situation. When centrally situated and consisting of a preponderance of giant cells, it presents a surface which rapidly reddens on exposure to the air, and these red tumours are generally non-malignant.² Sometimes, when it is composed of marrow elements with few myelo-plaxes and

¹ Clutton, *Trans. Pathol. Soc.*, 1884, vol. xxxv., p. 327.

² Wilks and Moxon, *Pathol. Anat.*, p. 59.

has undergone fatty changes, the colour will assume a greyish yellow. The consistence of the central growth is soft, while the peri-osseous variety is usually firm, and often fibrous bands or osseous spicula pass through it. The myeloid growths are liable to degenerations which, in a marked degree, modify their structure. Among these, the fatty and caseous generally attack old tumours of considerable size, and give them a yellowish appearance on section. Again, the tumours may undergo cystic and telangiectatic changes, and give rise to special symptoms, already alluded to in the article on pulsatile tumours of bone; pulsation is present in twenty per cent of the cases (Gross). The growth often contains a large number of cysts, which are produced by softening of the tumour tissue or by absorption of interstitial hæmorrhages. Occasionally, vessels of considerable size are traced into these cystoid cavities, where they occasion pulsation.

Myeloid tumours occur often in the young, at a period when the bones are undergoing important physiological changes. The most common age, however, appears to be between fifteen and thirty-five; the youngest fourteen, the oldest sixty-eight (Gross). More than half occur before thirty, and the vast majority of the tumours originate in the neighbourhood of the knee joint,¹ either in the femur or tibia. In their production injuries often appear to play an important part, for the disease in many cases dates its origin from the receipt of a slight traumatism. A case recorded by Wilks² well shows the connection between an injury and the development of a myeloid disease.

MYELOID DISEASE, LOWER END OF THE FEMUR.

Case 35.—James D., æt. twenty-five, a seaman, was admitted to Guy's Hospital under Mr. Cock's care on November 25th, 1854, with a large swelling above the left knee. He gave the following history of himself: that two years before while in London he struck the joint; that the blow caused it to swell and

¹ In fifty-three cases analysed by Schwartz, forty occupied the vicinity of the knee, the femur and tibia being attacked with about equal frequency. The head of the fibula was the seat of disease in seven cases.

² *Guy's Hospital Reports*, 3rd series, 1857, vol. iii., p. 168.

gave him much pain, and he did not recover for some weeks. He then went to sea, and for three months performed his duties, although the limb was weak and sometimes painful; after this it became so much worse that he went into the Leghorn Hospital. He again got better and resumed his work, but, his leg having swollen and being very weak, in October, 1853, he went to the hospital in Malta, where he remained some months; he was then sent to England. On admission into Guy's, a well-defined tumour was observed at the lower part of the left thigh, and appeared to originate in the condyles of the femur, which were much enlarged. The skin was tense and shining; the tumour felt hard, except at the sides where it was elastic, and it measured twenty inches in circumference; the joint admitted of some degree of motion. The leg was painful and slightly cedematous. Mr. Cock amputated the limb. On section of the tumour, the end of the femur was seen to be destroyed and replaced by a growth somewhat resembling the spleen in structure, there being a number of fibrous processes passing in all directions through it, like the trabeculæ of this organ, and in the midst was a red pulp. The latter was composed of myeloid matter, and the matrix of fibre tissue which proceeded in great measure from a layer of periosteum which passed off from the end of the bone. The sac was membranous, and the cartilages perfect below, and the shaft above ended by a jagged termination in the soft matter.

MYELOID DISEASE IN THE HEAD OF THE RIGHT TIBIA; EXPLORATION WITH REMOVAL OF GROWTH; SUBSEQUENT AMPUTATION THROUGH THE THIGH (STOKES'); SEPTICÆMIA; RECOVERY.

Case 36.—Joseph C., twenty-eight years of age, admitted into the Manchester Royal Infirmary in May, 1885. About eighteen months previously he jumped from a height of two yards, when he heard a distinct snap, apparently in the middle of his right knee joint, at the same time he experienced no pain. Three months after this he was running, when his knee gave way under him, he now had a slight pain. Eight months later, he struck his heel against an iron rod, which caused his knee again to give way, while the injury induced a great deal of aching in the limb. When he came under observation he complained of pain, varying in intensity, in the knee joint. It was worse in the afternoon, also just after going to bed. Occasionally he experienced a shooting pain, which commenced in the inner tuberosity of the tibia, and extended to the back of the knee joint. There are three tender spots in the vicinity of the joint, one over the insertion of the ligamentum patellæ, another just over the inner tuberosity of the tibia, and a third about two inches below the lower border of the patella. On pressing over the lowest of these spots indistinct fluctuation can be felt. There is scarcely any appreciable enlargement of the upper end of the tibia, and pulsation is quite absent. The movements of the knee were free and almost painless. Under chloroform the tibia was explored, and a maroon-coloured mass exposed. It occupied a cavity in the head of the bone, the size of a hen's egg. The soft mass was removed, the cavity plugged with iodoform gauze, and the wound dressed with moist carbolic gauze and wood-wool pads. The whole proceeding was carried out under the spray. The limb was fixed on a back splint. Soon after the operation the patient began to complain of a severe pain in his knee joint, which at the same time became hot, tender, and swollen. There was also excessive fever, with much constitutional disturbance.

The joint was punctured with a tenotomy knife, and a large quantity of sanguinolent pus evacuated. This gave temporary relief and reduced the fever, the temperature immediately before reaching 104° , afterwards it was 99° . It was very evident from local appearances and general symptoms that the knee joint was the seat of an acute suppurative inflammation. Amputation was therefore deemed necessary, and was practised through the lower part of the thigh by the plan suggested by Professor Stokes, of Dublin. After removal of the limb the cavity whence the myeloid mass had been removed three weeks previously was examined, and found to occupy the greater part of the head of the tibia, extending as far as the encrusting cartilage; the latter although thinned had not been destroyed. On the evening of the second day after removal of the limb the temperature rose to $104^{\circ}\cdot1$, the highest point yet reached. Fever of a remittent character continued, and a rigor took place on the third day after the amputation. The stump became red, œdematous, and painful, and relief was given by making multiple punctures with a tenotomy knife. Chest symptoms developed, and on examination the presence of fluid in the right pleural cavity was diagnosed. By means of an aspirator eight and a half ounces of a puriform serum were withdrawn. This was on the 19th August, and from this date an improvement set in; the temperature fell to normal and remained there; the stump, which for some time had exhibited signs of healing, soon cicatrised; and the patient on the 27th August was considered fit to return home. While the septicæmic attack was at its height and the temperature habitually reached 103° , and even a higher point in the evenings, the administration of antipyrin (30 grs.) was followed by a marked decline in the fever. This patient remains well and is able to follow his employment in the mill. The stump occasions him no inconvenience, and with the aid of an artificial limb he is able to walk a considerable distance without feeling fatigue. He was seen in March, 1887, and declared himself in excellent health.

Symptoms and Diagnosis.—When the disease originates in the upper or lower jaw, superficial portions of the growth project into the mouth, forming one form of epulis, which is recognised by its position and the dusky appearance which it presents; it is also softer than the fibrous epulis. Whenever the myeloid tumour springs from the epiphysis or diaphysis of a long bone, the difficulties attending the diagnosis will be very considerable. The growth is intimately attached to the bone, with which it is clearly continuous. Its density is frequently unequal, and often from pressure, the bone becomes so attenuated as to produce parchment-like crepitation, or a spontaneous fracture may take place. The question of pulsation in these tumours has been already discussed. Myeloid disease pursues an indolent course, its increase in size being slow, generally progressive, and not attended with much pain.

If, however, the tumour is so placed as to press upon a nerve, violent suffering may be experienced, especially when the rate of growth is rapid. Although a myeloid growth may completely replace the osseous tissue of an epiphysis, the articular cartilage resists the disease, and the neighbouring articulation often remains unaffected. Exceptions are, however, not unfrequent. In a case recorded by McCarthy,¹ where the upper fifth of the tibia had been almost entirely replaced by the myeloid growth, the articular cartilage of the tibia was normal. In the median line the growth had, however, spread up along the crucial ligaments to back of femur, and here changes had occurred in the cartilages, also in the patellar cartilage. So that a myeloid growth in the vicinity of a joint may possibly offer some impediment to its movement without endangering it very much. Instances have been met with where it has induced arthritis, with osseous displacements from destruction of ligaments. As a rule, it does not in any way impair the general health of the patient, nor does it show any tendency to implicate glands. In those rare cases where the tumour grows rapidly, and stretches the skin until it is destroyed, suppuration and ulceration attended with hæmorrhage may ensue, and this, exhausting the patient, often leads to a fatal issue. A remarkable example of the effects of ulceration in a peri-osseous myeloid of the radius came under observation some years ago at the Manchester Infirmary. After an exploratory incision the growth inflamed, large portions of it were expelled, and this continued until the whole mass disappeared and the wound cicatrised. The cure lasted at least two years; at the end of that time the man was lost sight of, so the ultimate result remains uncertain. An exact diagnosis as to the nature of a central bony tumour is hardly ever possible before removal. The presence of a myeloid may be strongly suspected when the various characteristics already indicated make

¹ *Trans. Pathol. Soc.*, London, 1881, vol. xxxii., p. 208.

their appearance. Location of the disease, its indolent, slow course, together with the age of the patient, deserve special recognition in forming a diagnosis.

Prognosis.—Myeloid tumours must be regarded as the least malignant of the sarcomas, and as being frequently of an innocent nature. In many cases they manifest no disposition to return when completely removed, and have but little tendency to dissemination throughout the system. Local recurrence, when observed, may often be ascribed to incomplete removal of the primary growth. An example of this is witnessed in the myeloid epulides, which are very apt to return when they have not been completely extirpated. Virchow rightly disapproves of the divorcement of the myeloid tumours from the other sarcomata, and communicates some cases of general infection in the myeloid growths of long bones.

Treatment.—The only effectual method of dealing with myeloid tumours is to remove them early and completely. In the myeloid epulis springing from the alveolus, the better plan is to take away, with the growth, the portion of bone on which it is situated. By this means a permanent cure may reasonably be expected. In other situations myeloid growths may be dealt with, either by free scraping and afterwards cauterising all doubtful spots, or by resection of the affected bone or by amputation.

Resection and Amputation.—In many situations excision of the bone, in which a myeloid growth originates, is impracticable. It has been tried in at least three instances in the lower extremity: the lower end of the femur in one case,¹ the upper end of the fibula in the other,² and lower end of tibia in a third;³ but the results obtained were not such as would warrant a repetition of this plan of treatment. Besides, it has been proved that excision is more fatal than amputation by

¹ Billroth, *Clinical Surgery*, 1881, p. 451.

² Langenbeck's *Archiv*, vol. xxi., p. 331.

³ Billroth, *Clinical Surgery*, 1881, p. 450.

three per cent, although most of the former have been practised on the bones of the upper extremity, while the thigh has generally been the seat of amputation. As myeloid tumours are usually confined within the limits of the bone in which they grow, the rule with regard to amputation should be to divide the bone well above the seat of disease.

EXAMPLE OF RESECTION IN A MYELOID GROWTH OCCURRING IN THE UPPER EXTREMITY.

Case 37.—Mr. Lucas's patient,¹ a healthy-looking woman (age not stated), admitted into Guy's Hospital in August, 1876. About nine or ten months before admission she had first noticed a slight swelling at the lower third of the left ulna; this was accompanied by a gnawing pain, and gradually increased in size. There was found a firm, dense, elastic swelling occupying the lower half of the left forearm on the ulnar side, extending about two and a half inches above the wrist joint. The surface was smooth and convex, and the skin not adherent except over a small cicatrix. The tumour was not painful on pressure, and the glands above were not enlarged. The movements of the wrist were perfectly free, but pronation and supination were somewhat interfered with. Chloroform having been administered, Mr. Lucas made a longitudinal incision about four inches in length on the inner side of the forearm, so as to expose the tumour between the flexor and extensor carpi ulnaris muscles. In so doing the posterior branch of the ulnar nerve was exposed and divided. The muscles and skin were now retracted to the sides, and the bone exposed above the level of the tumour. In order to clear the bone above the wound, it became necessary to make a short transverse incision at the upper part of the wound. A blunt knife was then passed between the radius and ulna, and the latter bone divided with a saw. The further steps of the operation presented no difficulty, and the triangular fibro-cartilage and the wrist joint were left intact. Very little constitutional disturbance followed, and the patient left the hospital four weeks after the operation with the wound healed. Microscopical examination showed the tumour to be a characteristic myeloid growth. Excision of the ulna did not interfere with pronation and supination, and the patient regained free use of her hand. Quite lately (June 2nd, 1887) I have heard from Mr. Lucas that this patient has never had any return of the disease. The ulna is replaced at the lower part by a strong fibrous band, and the hand remains in its proper line with the forearm, and has done a great deal of work during the last ten years.

At the same meeting of the Clinical Society of London, Mr. Henry Morris read a paper² "On a case of myeloid sarcoma of the left radius in which the lower ends of the radius and ulna were excised, leaving a useful hand."

¹ *Lancet*, vol. i., 1877, p. 574.

² *Lancet*, vol. i., 1877, p. 574-5.

Case 38.—When the patient came to the Middlesex Hospital on January 3rd, 1876, thirteen months after a fall upon her hand, and ten months after the commencement of the swelling, the lower end of the left radius was expanded into a large rounded tumour. The inner surface of the ulna was quite free and could be traced down to the styloid process, but its radial border was overlapped by the expanded radius on both the flexor and extensor aspects. On the 8th of March, chloroform having been administered and Esmarch's bandage applied to the hand and forearm, a long incision was made over the outer side of the radius, extending from the styloid process to the upper third of the bone. The radial nerve was looked for, and used as a guide to the interval between the supinator longus and extensor carpi radialis longior muscles, as Mr. Morris had previously satisfied himself that he could most readily separate the soft structures from the front and back of the radius by going between these muscles and keeping the supinator to the fore part of the incision. The supinator longus and the pronator radii teres at their insertions were detached from the radius, and the bone, when freed both in front and behind of its muscles, was sawn through at the lower edge of the supinator brevis by a chain saw. A second longitudinal incision, of less extent than the first, was made along the inner side of the ulna, from the wrist joint upwards, and through it the rest of the soft structures were separated from the tumour and from the lower part of the ulna. The ulna was divided by the chain saw between three and four inches above the wrist, and the lower ends of both bones of the forearm were disarticulated by opening the wrist joint on the inner side. This done, the entire tumour, together with the ulna and the pronator quadratus muscle, which was thinly and tightly spread over the tumour, were removed *en masse*. When examined, after removal, the tumour proved to be of a typical myeloid character. It was confined within the radius, which formed a thin and imperfect shell, on the dorsal surface of which were seen the grooves and markings of the extensor tendons. The ulna was firmly attached to the tumour, partly by the pronator quadratus, and partly by adhesions between the periosteum of the ulna and the capsule of the tumour. The patient did uninterruptedly well. A leathern splint was moulded to the forearm and carpal part of hand. When out of the splint her hand hung down loosely, like a flail, still it was very useful. On the 11th of January, 1877, she was last seen. She was wearing the same splint, and with it on could move her thumb and each of her fingers fairly well; she was able to pick up a pin, and could hold a fork. She had been using the hand a good deal for washing, holding the wet linen in the left while she wrung it dry with the right hand.

The following case of resection for a central sarcoma has been published by Mr. F. A. Southam:¹

RESECTION OF THE UPPER END OF THE HUMERUS FOR A SARCOMATOUS TUMOUR.

Case 39.—Annie H., aged thirty years, presented herself at the surgical outpatient room of the Manchester Royal Infirmary, April 22nd, 1886, complaining of a swelling in the neighbourhood of the right shoulder with loss of power in the

¹ *Medical Chronicle*, January, 1887, vol. v., No. 4, p. 291.



arm. She stated that about nine months previously she had received a blow on the upper and outer aspect of the limb. The injury, which was not of a severe nature, was at once followed by loss of power in the arm, which was permanent, but by no other symptoms until about a fortnight before coming to the hospital, when, for the first time, she observed that the shoulder was somewhat swollen. On examination of the patient the head and upper portion of the shaft of the humerus were found to be slightly enlarged, a distinct fulness being perceptible on the front and outer aspect of the joint. There was an entire absence of any inflammatory symptoms; the patient complained of very little tenderness, either on direct pressure over the head of the humerus, or on pressing the articular surfaces of the joint together. There was no perceptible local increase of temperature or redness of the skin, and she felt no pain except when she attempted to raise the arm from the side. Taking into consideration the history of the case and the physical signs—the fact that there was a distinct enlargement of the upper end of the humerus, that it appeared some time after an injury, and that it was attended by an absence of any evidence of inflammatory action, especially of pain—it appeared probable that the swelling was due to the presence of a new growth springing from the interior of the bone, and most likely of a sarcomatous nature. To confirm the diagnosis it was determined to watch the case for a short time, meanwhile adopting a treatment under which the swelling, if simply inflammatory, would probably diminish in size, or at any rate remain stationary. The arm was therefore fixed to the side, so as to maintain the joint in a state of complete rest, and some evaporating lotion was kept constantly applied to the shoulder. On examining the patient again after the lapse of a month, all doubt as to the nature of the case was removed; for, as had been suspected when first seen, it was now quite evident that a new growth was present. The enlargement of the end of the bone had become more marked; on pressing upon it at different points a characteristic “egg-shell” crackling could be distinguished. It was further found that the bone had completely given way, just in the situation of its surgical neck, distinct crepitus with mobility being detected at this spot.

Operation, June 3rd. Shoulder joint was freely exposed by turning up a large deltoid flap, and the capsule opened; the head of the humerus—having been disarticulated and turned out of the wound—was then removed, along with about four inches of the shaft, care being taken to keep clear of the disease, which as yet appeared to be confined to the upper epiphysis of the humerus, for the glenoid cavity, capsule, and surrounding tissues were apparently quite free from infiltration with the growth. The wound was then closed, a large tube being inserted so as to drain the glenoid cavity from its bottom. The patient, after the operation, progressed favourably.

Examination of the tumour, which was almost the size of a fist, showed that it was a typical example of a central or myeloid sarcoma, springing from the interior of the upper epiphysis of the humerus. The cancellous tissue of this portion of the bone was completely destroyed, being replaced by a soft growth, which, in the recent condition, was of a dark-red or maroon colour (*Plate vi.*). The compact tissue was much thinned, and in places entirely gone, thus accounting for the crackling sensation observed on pressing upon the tumour before it was removed. The destruction of the osseous tissue was so complete in the situation of the surgical neck that the bone had quite given way. The cartilage investing the head

was still intact, and the joint had escaped implication. Sections of the tumour showed that it was made up of round and spindle cells, intermingled with which were a considerable number of myeloid or multinucleated elements. The patient, who was exhibited at a meeting of the Manchester Medical Society, on December 3rd, had a very useful limb considering that so much bone had been removed. She can raise the hand to the mouth, and use the arm for house work, as well as for working a small sewing machine. The deltoid muscle has become extremely wasted and the shoulder flattened, the acromion and coracoid processes standing out prominently beneath the skin. As the arm hangs by the side there is a distance of about four inches between the acromion and the upper end of the shaft of the humerus, which can be plainly felt rounded off through the integuments (*fig. 68*).

FIG. 68.



FIG. 68.—Arm after resection of head of humerus for central sarcoma (*Mr. Southam's case*).

Recovery after operation in myeloid disease may be permanent. Gross considers that only 22·72 per cent of all cases of myeloid tumours are malignant, and that of growths, in which calcification or ossification is not noted, only one was characterised by secondary deposits. One may, therefore, regard it as certain, that central myeloid tumours, in which no calcifying or ossifying processes have occurred, are practically innocent growths.

SPINDLE-CELLED CENTRAL SARCOMAS.

Next to the myeloid growths, these constitute the most common form of central tumours of bone. Butlin, in a collection of eighty-one central growths, tabulates nineteen spindle-celled tumours distributed as follows: Femur, five (two in the upper end, a rare situation); tibia, five; tarsus and metatarsus, one; humerus, three; ulna, one; clavicle, one; scapula, one; lower jaw, two. They constitute rounded or oval, smooth or slightly nodulated tumours, surrounded by a capsule, which is bony or periosteal, or partly membranous and partly osseous. On section, they present a greyish-white, smooth, glistening surface, which is generally firm and elastic. When the growth is the seat of fatty changes, yellow patches will be observed. As the vessels permeating the growth are very fragile, they often give way, and extravasations of blood result, imparting a brownish appearance to certain portions of the surface. Central tumours composed of spindle cells attack the diaphyses of long bones much more frequently than the myeloid growths, and are less often encountered before thirty years of age than the latter. Both forms of tumour exhibit the same slight disposition to advance beyond their fibro-osseous envelope; consequently they generally leave the neighbouring structures (soft tissues and lymphatic glands) unimpaired, unless their displacement is brought about by the increasing neoplasm. The diarthrodial cartilage usually remains intact. A case¹ is mentioned by Volkmann in which the cartilage covering the head of the humerus had suffered sarcomatous degeneration and was perforated in several places.

Spontaneous or easily produced fractures occur in nearly one-half of all cases of spindle-celled central sarcomas of bone (Gross), and is a valuable symptom when preceded by pains chiefly confined to that part of the bone where the break is seated. Localised bone pain followed by a fracture from a

¹ Langenbeck's *Archiv*, vol. xv., p. 563.

slight cause, and a swelling which increases with more or less rapidity, is a symptom the significance of which cannot be overlooked. The tumefaction associated with the fracture subsides, and the sarcomatous tumour declares itself in a very unmistakable manner.

The associated lymphatic glands are not enlarged in the spindle-celled central tumours, but they may become affected in the dissemination through the blood. Pulsation and other signs of aneurism are observed in twelve and a half per cent of all cases of spindle-celled growths (Gross), and parchment-like crackling is produced when the tumour is confined within a thin osseous capsule.

ROUND-CELLED CENTRAL SARCOMAS.¹

Syn. ENCEPHALOID SARCOMAS (CORNIL AND RANVIER); GRANULATION SARCOMAS (BILLROTH).

The structure of these sarcomas bears a close resemblance to that of superficial granulations. They consist of a preponderating amount of small round lymphoid cells, each of them furnished with a round or oval nucleus; the intercellular material is soft, amorphous, and insignificant in amount. When the cells are large, and possess one or more nuclei with bright nucleoli, and are imbedded in a fibrillated intercellular substance, the whole having an alveolar arrangement, the tumour takes the name of Alveolar Sarcoma, first given to it by Billroth. (For a typical example, see Alveolar sarcoma of the tibia, Billroth's *Surgery*, vol. ii., p. 408.)

ROUND-CELLED CENTRAL SARCOMA, UPPER END OF FEMUR; FRACTURE; AMPUTATION AT HIP JOINT; RECOVERY; RECURRENCE OF DISEASE; DEATH.

Case 40.—Mr. S., fifty-three years of age, complained in December, 1884, of pain in the upper part of the left femur, which was accompanied by a distinct change in the contour of the bone. A central growth was suspected, and the patient was warned against the possibility of a fracture taking place from a trivial

¹ Their chief seat is the epiphyses, the femur and humerus being chiefly attacked. The os calcis was involved in four out of eighteen cases (Schwartz).

cause. About a fortnight afterwards he broke his thigh by falling, his foot having been caught in a hole in the floor. He now came under the care of Mr. Quicke, a surgeon in this city, to whose unremitting care his recovery from the amputation was mainly to be attributed. The fractured thigh was treated with Hodgen's apparatus, but no union could be effected, and very soon the swelling began to

FIG. 69.



FIG. 69.—Round-celled central sarcoma, upper part of femur; fracture; rapid extension of growth; amputation at hip joint (*case 40*).

increase at a considerable rate. We now had the advantage of Mr. Lund's experience, and at our consultation amputation was advised. To this the patient would not consent for some months, and when exarticulation was practised it was found that the growth had already infected the neighbouring tissues, more especially the

muscles on the outer aspect of the thigh. The skin was intact, the lymphatic glands not enlarged at any time, nor was there any pulsation in the growth. Convalescence was exceedingly tedious, and interrupted by a maniacal condition which lasted two months. The wound never completely healed, a small sinus remaining, which, however, did not occasion any inconvenience, nor did it prevent him from going about on crutches. About six months after the amputation (performed June 23rd, 1885) the stump became fuller, and the patient began to experience much more pain in it. The hope was entertained that the trouble was inflammatory in character, produced by exposure and jolting during a journey to see a friend. Rest in bed was enjoined, with, however, no improvement, the swelling steadily increasing. On the 9th February, 1886, he was anæsthetised and the sinus explored; our worst fears were realised in the discovery of a soft growth invading the cut ends of the muscles. This increased somewhat rapidly and proved fatal in a few months. There was no post-mortem examination, so the condition of the organs must remain a matter of speculation. It is very probable there were some secondary growths in the chest, as the patient had on several occasions suffered from symptoms of pleurisy, accompanied with an exceedingly troublesome cough. The disease extended over a period of at least eighteen months.

Central tumours of the *round-celled variety* grow more rapidly than any other central tumour of bone, reaching a considerable size in the space of a short time. This being the case, their limiting capsule is more apt to be perforated, and the tumour more prone to infiltrate surrounding structures. Of all the central sarcomas they are the most malignant, and more than half of them occur before thirty years of age. In twelve cases given by Gross, seven occurred in the femur (upper epiphysis three, lower epiphysis two, shaft two); the tibia was affected in two cases (upper epiphysis one, shaft one); while three were seated in the humerus (upper epiphysis two, shaft one). The average age was twenty-eight years, and the growths were less common by eight per cent than the myeloid sarcomas, but more common before that age by twenty per cent than the spindle-celled variety.

The vascularity of these tumours varies. The ordinary form, composed of a structure resembling that of ordinary granulations, has a scanty supply of blood-vessels; while in other varieties vessels of considerable size permeate the structure, producing symptoms simulating those of aneurism. Pulsation is observed in round-celled central sarcomas much more frequently than in the myeloid tumours, and nearly three

times as often as in the spindle-celled variety (Gross). Another important point in connection with the pulsation must here be mentioned. The pulsating myeloid growths are strictly confined to the epiphyses. On the other hand, pulsation occurs as frequently in the round-celled tumours when they attack the shaft as when they are situated in the epiphyses. Spontaneous fractures occur in about half the cases (Schwartz). Generally speaking, central round-celled growths are less malignant than corresponding tumours of superficial origin (Butlin), but have a more rapid course than the other central growths. They may infiltrate the medulla of bones in which they arise; also the soft parts, in case they perforate their capsule, while the cartilage of incrustation usually remains intact. There are, however, certain exceptions. Bryant records a case¹ in which the upper end of the femur was the part attacked, and where the cartilage was invaded by the sarcomatous tissue.² Glandular implication is rarely seen except as the result of systemic infection, which is brought about by sarcomatous elements gaining access to the blood current. In some instances large veins may be filled with the material of the tumour (Gross). Dissemination under such circumstances can easily be produced by fragments of the growth being carried back with the blood, much in the same fashion that portions of a soft, infective thrombus are conveyed in cases of embolic pyæmia. The four cases of central sarcoma of the skull in Mr. Butlin's tables all belonged to the round-celled variety, three attacking the vault, and one the sphenoid bone. They differed from the cranial subperiosteal tumours in the patients being much older, and the growths being less frequently multiple.

¹ *Guy's Hospital Reports*, Series 3, vol. xx., p. 360. Mr. Sydney Jones records (*Trans. Pathol. Soc.*, London, 1882, vol. xxxiii., p. 337) a case of round-celled sarcoma occupying upper of humerus and extending to articular cartilage. It occurred in a man thirty-six years of age, with a history of cancer, and followed an injury.

² Mr. Eve, *Trans. Path. Soc.*, London, 1881, vol. xxxii., p. 169, mentions a very interesting case in which a sarcoma of lower end of femur extended into knee joint, simulating destructive disease of the articulation.

Treatment.—The mode of dealing with the spindle-celled and round-celled central sarcomas of long bones is very similar, and will generally consist in amputation at a reasonable distance from the seat of disease. When the growths have invaded the soft parts in the vicinity of the bone, amputation should be carried out at a much higher point, and, whenever possible, above the origin of any muscles that may be infiltrated. In central tumours originating in the epiphyses or articular ends of the bones, the probability of the growth having extended along the ligaments to the neighbouring joints will often necessitate amputation through the continuity of the bone above. No attempt should be made to remove sarcomas of the skull.

The general conclusions, summarising the chief differences between the three foregoing varieties of central sarcoma, are:

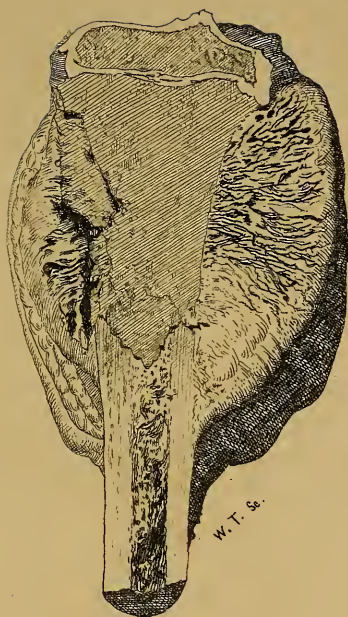
1. All of them are malignant.
2. The order of malignity, starting with the variety which exhibits it most, is round-celled, spindle-celled, giant-celled.
3. Myeloid growths occur at an earlier age and are marked by lymphatic involvement¹ very much less frequently than the round-celled, which are the most pernicious.
4. Lymphatic glands never enlarged in spindle-celled tumours. This is also true of the same variety when met with growing from the periosteum.
5. A central sarcoma arising within the shaft of a long bone is usually composed of round or spindle-cells.

SUBPERIOSTEAL, PERI-OSSEOUS, OR PERIPHERAL SARCOMAS (Plate 9).

These are connected with the outside of the bones, and arise from the deeper or osteogenic layer of the periosteum. As they grow they displace the fibrous membrane, separating it from the underlying bone. In many cases, the periosteum itself

¹ Glandular enlargement when it occurs is usually simply the result of irritation, and subsides when the growth is removed.

PLATE, 9. ✓



becomes involved in the sarcomatous invasion, is destroyed or rather converted into sarcoma tissue, and is incorporated with the growing tumour. This allows the components of the neoplasm to infiltrate the soft structures in the vicinity of the bones; while the latter may escape infection altogether or they may be superficially invaded. In rare instances, the disease travels along the Haversian canals to the interior, or it may reach the spongy tissue of the epiphyses.

The subperiosteal sarcomas are composed of spindle or round cells, or these two varieties may exist in varying proportions and constitute a third form of tumour named the mixed celled (Butlin). All the peripheral growths possess one common property, namely, a great and peculiar disposition to those forms of degenerations called respectively calcification and ossification, and this is not remarkable when we remember the characteristics of the tissue in which they originate. Myeloid cells are not generally observed in the peri-osseous sarcomas, except in those portions of the growth nearest to the bone. The old subdivision of osteoid cancer must now be abandoned, the majority of tumours formerly included in this class being ossifying or calcifying forms of subperiosteal sarcomas. There is every reason to believe also that some of the ossifying chondromas have been classed as osteoid cancers. The retention of the term only tends needlessly to complicate a subject already bristling with difficulties. I shall, therefore, dismiss it with the above observations; at the same time advising the reader, should he desire further particulars, to consult Mr. Walsham's paper.¹

SUBPERIOSTEAL SARCOMA, LOWER END OF LEFT FEMUR; AMPUTATION OF THIGH.

Case 41.—James B., æt. seventeen, admitted into the Manchester Royal Infirmary, April 1st, 1884. Is employed as a labourer in some boiler works. Has always enjoyed good health. Last Christmas he noticed that after he had been sitting for some time, upon getting up, a sharp pain came in his left knee on extending it. He had no difficulty in locomotion for a month after this, when he

¹ *St. Bartholomew's Hospital Reports*, vol. xv., 1879, p. 111.

noticed that the movements of his knee were less free, and he also found that there was a considerable swelling on the outer side of the thigh, about four inches above the knee joint. The swelling has not increased very much in size, nor has there been much pain, such as there has been, being of an aching kind, but it has not interfered with his sleep. Patient has a rosy complexion, and is well-nourished. Above the knee on the outer side there is a somewhat diffuse swelling, the lower part of which reaches to within two inches of the joint. It has a firm elastic feel, is adherent to the bone, and the skin, which is normal in colour and temperature, moves freely over it; no fluctuation, no pulsation, nor can any bruit be heard. It is rather tender to the touch, especially where the swelling is most marked, that is, at the lower and anterior part. An exploratory incision confirmed the diagnosis of periosteal sarcoma. The thigh was therefore amputated at the upper part of middle third. With the exception of a very limited sloughing of the anterior flap the case progressed satisfactory, and the lad left the Infirmary on the 7th of May with the stump quite cicatrised. Inquiries lately made have shown that this patient died in the early part of 1885 of what was supposed to be consumption, but in all probability from a recurrence of the disease in the lungs. As far as could be ascertained the disease did not return in the stump.

Ossification or calcification is observed in about two-thirds of all the peripheral sarcomas, and in some the changes have advanced to such a degree that, when the softer portions have been removed by maceration, a bony skeleton or framework is left, which might be mistaken for a spongy exostosis or an osteophyte (Gross).

The *femur*¹ is more frequently the seat of peripheral sarcoma than any other bone, and the symptoms of the disease are perhaps best observed here. It is attacked indiscriminately by all the varieties, and the lower portion of the bone, either the end of the diaphysis or the epiphysis, appears to be the position of choice (*fig.* 70). The disease occurs most frequently between the ages of ten and thirty years, and attacks males much more often than females. It constitutes a soft, elastic, fusiform swelling, which enlarges rapidly and continuously, with occasional signs of inflammation, distending the skin, and sometimes causing it to ulcerate. Involvement of lymphatic glands is not often observed, and pulsation is never present.

¹ Mr. Pye Smith (*Lancet*, 1883, vol. ii., p. 144) gives an interesting example of an ossifying mixed-celled periosteal sarcoma of femur in a lad, nineteen years; history of blow two years previously. Amputation of thigh; death three and a half months afterwards. No recurrence in stump of femur. Secondary growths behind sternum and in front of dorsal vertebræ, also in right lung.

Degenerations constantly occur, and of these ossification, calcification, and chondrification are the most constant; while mucoid softening, with the formation of cystoid cavities, is not

FIG. 70. ✓



FIG. 70. — Large round-celled subperiosteal sarcoma, lower end of femur.
Bone itself invaded (*O. C. Museum*).

unfrequently seen (*fig. 71*). A history of an injury preceding the formation of the growth will be obtained in about a third of the cases. Local infection and dissemination to distant

organs is often witnessed, especially in the spindle-celled variety. The disease usually lasts from nine to fourteen months.

Although invasion of the knee joint very seldom happens, the growth may infiltrate the synovial membrane, protruding

FIG. 71. ✓

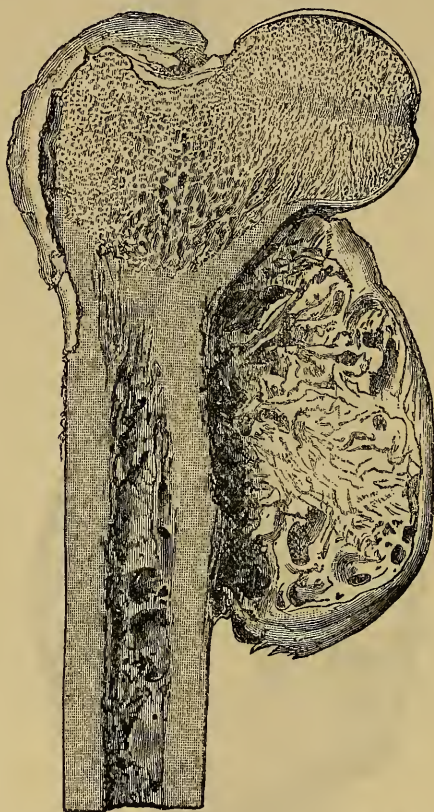


FIG. 71.—Cystic peri-osseous sarcoma of the upper end of femur
(O. C. Museum).

into the articulation without, however, involving the cartilage (*plate iii., antea*). In these cases a suspicion of the disease being a white swelling might easily arise: the exact situation and shape of the swelling, its precise relations to the patella,

the history of its formation, together with the condition of the joint in regard to movement, should be kept in view when the diagnosis is made. The growth extends along the femur, which either remains unaffected, is superficially involved, or the disease spreads through it and implicates the interior. The bone is but seldom fractured. The spindle-celled variety possesses the most pronounced malignant characters; every case in which it occurs showing signs of malignity at some time or other in its course.

Treatment.—Early amputation at a considerable distance from the upper limits of the swelling should be practised; even then the probabilities of prolonging life are excessively small, still the removal of a constant source of anxiety will have a beneficial influence, and death, if from an internal growth, is far less terrible to witness. The importance of undertaking the operation before the tumour has penetrated the periosteum and become locally disseminated is very obvious.

Next to the femur, the *tibia* (figs. 72, 73, 74) is most frequently attacked with peripheral sarcoma, the proportion between the tumours of these two bones, in Butlin's table of eighty subperiosteal tumours, being as twenty-eight to thirteen. The spindle-celled variety is only represented by two cases, while four of the remaining eleven belonged to the round-celled

FIG. 72. ✓



FIG. 72.—Ossifying subperiosteal sarcoma, upper end of tibia (O. C. Museum).

and seven to the mixed-celled varieties, four occurred in patients of fifty years and upwards, and only one in the person of a child. The upper extremity of the bone is the part most generally affected (*plate 9*), the tumour springing from the head or its vicinity. Steudener¹ gives an interesting example of a growth

FIG. 73.



FIG. 73.—Spindle-celled subperiosteal sarcoma, lower end of tibia, anterior view (*O. C. Museum*).

originating from the front of the head of the tibia, and producing diffuse sarcomatous degeneration of the synovial membrane and of the sub-crural bursa.

¹ Virchow's *Archiv.*, vol. xlv., p. 500.

Peri-osseous sarcomas of the tibia are less rapid in their growth, and, as a rule, display fewer evidences of malignity than the corresponding tumours of the femur. Extensive dissemination is rare, and Butlin could only find one case in which the lungs were affected. Glandular implication was observed in two cases only.

FIG. 74.

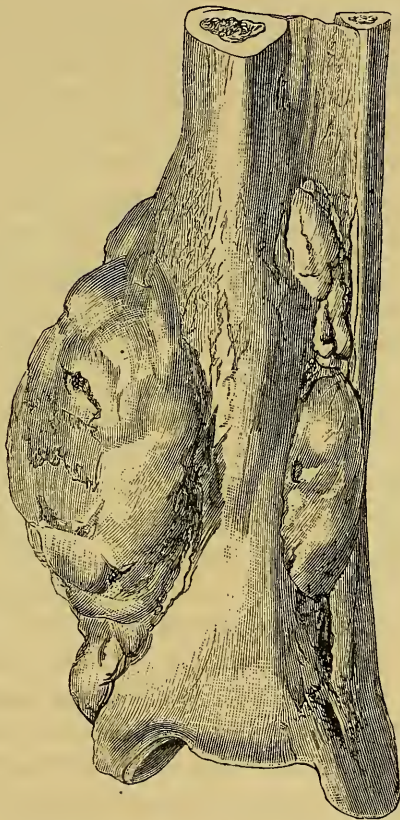


FIG. 74.—Spindle-celled peripheral sarcoma, lower end of tibia, posterior view of *fig. 73* (*O. C. Museum*).

Attention to the following points will serve to distinguish the subperiosteal from the central tumours of the tibia: 1. Exact situation and limits of the growth, the central being

almost always above the conjunctive cartilage. 2. Rate of growth; quicker in the subperiosteal. 3. Presence or absence of egg-shell crackling; not by any means always present in central, never in subperiosteal. 4. Presence or absence of pulsation; when present always denotable of a central growth.

In the diagnosis of peripheral sarcoma of the tibia from chronic inflammation of the knee joint, it is most essential to ascertain the exact position, shape, and mode of origin of the swelling, to determine its rate of increase and its effects on the patient's general condition. Very frequently it will be found that a growth springing from the periosteum is much more prominent on one side of the articulation, while a white swelling produces a tolerably uniform tumefaction. This combined with the steady, progressive increase in the tumour, and its complete resistance to all ordinary means of treatment, will stamp it as a disease other than that connected with inflammation.

Treatment.—No time should be lost in resorting to amputation as soon as a diagnosis has been formed. The operation should be practised through the thigh, except in cases where the disease is far removed from the knee, which is rare; when amputation through the joint might be resorted to with propriety. The dangers attending amputation are not great, and the prospects of completely ridding the patient of the disease, although small, are certainly greater than in similar tumours of the femur. The disease rarely recurs in the stump and then only in the soft parts, but dissemination takes place to other and distant parts of the body. What has been said about tumours of the tibia applies, with scarcely any modification, to those connected with the fibula; the same rules obtain in regard to diagnosis, and similar treatment has to be adopted; their number, however, is comparatively limited.

TRAUMATIC, OSSIFYING, ROUND-CELLED SUBPERIOSTEAL SARCOMA, SPRINGING FROM THE MIDDLE OF THE RIGHT FIBULA; AMPUTATION THROUGH THE KNEE JOINT; RETURN AND DISSEMINATION OF THE DISEASE; DEATH.

Case 42.—William F., thirteen years of age, errand boy, admitted into the Manchester Royal Infirmary, April 20th, 1883. Father died of phthisis, otherwise family and personal history good. Eight weeks ago, he received a slight blow on the outer side of the right leg, very slight pain followed, and no particular attention was given to the injury for a week. It was then noticed that the limb began to swell, and that it was painful, especially at night. The swelling, soft at first, became gradually harder. From this time the growth advanced with great rapidity, and the disease resisted all treatment. On admission, we found a hard, diffuse swelling on the outer side of the leg, extending from an inch below the head of the fibula to within three inches of its lower extremity. At the centre the swelling extended from the crest of the tibia round to the back of the leg. There was no

FIG. 75.

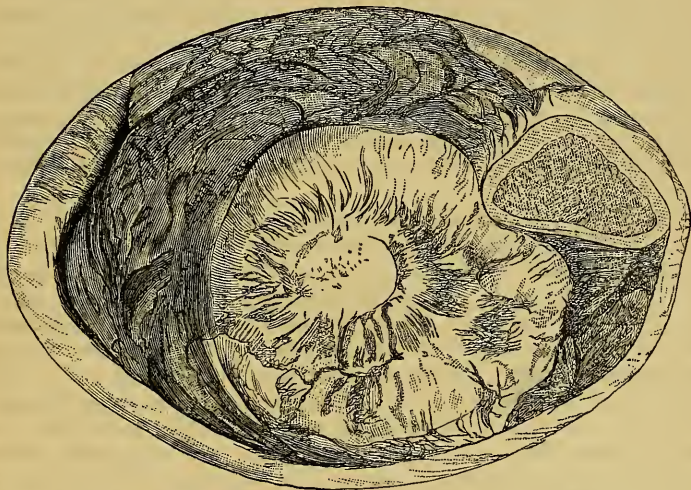


FIG. 75.—Transverse section of the leg, showing a traumatic, ossifying, round-celled subperiosteal sarcoma of the fibula (*O. C. Museum*), case 42.

fluctuation or pulsation, but a very distinct elevation of local temperature in the parts covering the tumour. The pain he described as a pricking sensation, extending from the swelling to the sole of the foot, and as much worse at night. The skin, although tightly stretched over the tumour, was not adherent to it. Subcutaneous veins prominent. No glandular enlargement or constitutional disturbance. The growth could not be moved independently of the bone. On the following day, the swelling was punctured with a grooved needle, a few drops of blood only escaping. In four days the tumour had materially increased; it was again punctured in two situations, where there appeared to be a semi-fluctuant sensation; results again negative. The swelling steadily increased without, how-

ever, producing any marked general fever, the temperature generally being about 99°. Exploration under chloroform, after a week's delay, a solid mass was detected springing from outer surface and posterior aspect of fibula, also infiltrating neighbouring muscles. A portion of the growth removed was of a reddish colour and soft consistence. Microscopically, it was pronounced to be a round-celled sarcoma. Amputation through knee joint performed, patella and cartilage covering condyles left untouched. Examination of limb showed that the new growth almost encircled the fibula, which was itself invaded by the disease. Spicules of new osseous tissue, radiating from the fibula, extended into the growth. The after progress of the case as regards the amputation does not call for many words; the stump healed with scarcely any trouble, some slight sloughing of the edge of the long anterior flap being the only incident of importance. The lad left the Infirmary about a month after the operation, and remained at the Cheadle Convalescent Hospital for a few weeks. Some two months after his return home, I was requested to see him about a swelling, which had made its appearance in the left hip. I found a very distinct mass occupying the upper and outer part of the left thigh, evidently connected with the femur at the root of the trochanter. On examining the stump I discovered a fulness on the under surface, which appeared to be in the soft parts, and not intimately attached to the bone. It was very evident the growth had returned; more than that, the swelling in the left hip showed contamination of the system. With the view of watching the case more closely, the boy was readmitted into the Infirmary, and very soon other growths appeared in connection with the calvarium. He was removed home shortly before death, which took place in September, 1883.

The results of the post-mortem examination were furnished to me by Mr. H. W. Pomfret, F.R.C.S., at that time my house surgeon: Body much emaciated; large swellings, which pulsated during life, found on the left side of forehead, reaching down to the orbit, with protrusion downwards and outwards of the left eyeball. Prominence about right parietal bone; enlargement of stump and great thickening about left hip. The enlargement over left orbit was due to a growth springing from the external surface of frontal bone, and spreading backwards into the orbit along the under surface of the orbital plate, which was perforated about its centre, the growth extending into the cranium and pressing against the frontal lobe of the brain. Connected with the right parietal bone was a large mass growing principally from the internal surface, causing a great indentation in the right cerebral hemisphere. The bone was also eroded and perforated, part of the growth extending through the perforation, causing the prominence visible externally. Connected with the internal surfaces of the third, fourth, and fifth ribs of the right side, external to their angles, was a mass pressing on the lung. The growths in the extremity were connected with the end of the stump, chiefly posteriorly, with the great trochanter and neck of left femur, also with the condyles of the same bone. There was also a small nodule in the left testicle and in the left iliac fossa, probably in connection with the lymphatic glands. All these growths presented microscopic characters similar to those of the original tumour. No secondary deposits were found in any of the internal organs.

This case constitutes an excellent example of acute traumatic malignancy, where a cancerous growth quickly follows an

injury. The appearance of the sarcomatous tumour soon after and at the seat of injury makes the connection between them something more than a casual coincidence. We are forced to admit that the injury and growth stand to each other in the relation of cause and effect. The injury produces a rapid cell multiplication, ending in a malignant disease which is characterised by the appearance of a collection of cells and their offspring. It has yet to be explained why an injury, often of a trivial nature, will in some cases induce a rapid cell proliferation, producing a disease which exhibits malignancy in its ugliest forms, while in another case, under conditions apparently similar, it simply terminates in a simple inflammation. Does this peculiarity reside in the tissues themselves, or is it derived from a general constitutional state? Billroth and others assume in such cases the presence of a constitutional diathesis in which there is a marked tendency to the development of sarcoma. The person who receives the injury is the possessor of an occult condition which only requires the infliction of an injury, before it manifests itself in a dangerous and fatal disease. Such an explanation scarcely offers an adequate solution of the difficulty, and so far nothing is known concerning the constitutional condition so intimately associated with the tumour formation; its presence remains unsuspected until it is revealed by the production of the growth.¹

Sarcoma of the Foot.—Sarcomas may originate in the bones of the tarsus or metatarsus, and form either subperiosteal or central growths. Gosselin² met with a subperiosteal sarcoma the size of an orange in a woman fifty-nine years of age. The tumour was situated on the dorsum of the foot, and attached to the scaphoid and astragalus, forming a hard irregular mass

¹ For detailed information on this subject, and reports of interesting cases, the reader is referred to the following papers: Barwell, *British Medical Journal*, 1882, vol. i., p. 187; Butlin, *idem*, p. 403; Walter, *idem*, p. 458; Cripps, *idem*, p. 653; Gould, *Lancet*, 1885, vol. ii., pp. 994 and 1035; Puzey, *British Medical Journal*, 1882, vol. ii., p. 837; Ormsby, *Lancet*, 1884, vol. ii., p. 138.

² *Bull. de la Soc. Anat.*, 1866, p. 139.

painful on pressure and in walking. Amputation at the ankle joint was performed. Guérin describes a case of spindle-celled subperiosteal sarcoma occurring in a man sixty-seven years of age. The growth formed a fungating mass in connection with the great toe, and had a history of six months' duration. It was removed and rapidly recurred. Similar cases have been published by Lebert, Virchow, and Lücke. These and other cases bear out the view expressed by Mr. Butlin, that tumours of the foot possess a higher degree of malignancy than tumours of the thigh and leg. Chassaignac¹ removed with the fifth metatarsal bone a pulsating sarcoma originating in the periosteum of this bone. The tumour of the size of an egg had developed in two months in a man aged twenty-two. It was composed of spindle with some myeloid cells. Several examples of sarcomas arising in the interior of the bones of the foot are recorded by Delorme.² Some difficulty will be experienced at the onset in distinguishing the central growths from osteitis. The pain in the tumour is more limited, and is uninfluenced by rest and treatment, and suppuration is absent. The most prudent course to follow in case of doubt, is to explore.

The treatment to be adopted in sarcomas of the foot is amputation at a sufficient distance from the seat of disease. In the subperiosteal forms of tumour, extirpation of the growth with *evidement* of the bone has been considered sufficient, but in view of the malignity of these sarcomas in the foot, this proceeding can scarcely be deemed a prudent one. Amputation should undoubtedly be the general plan of treatment. The prognosis in all forms of sarcoma of the foot is very unfavourable, generalisation being very frequent (Virchow).

Peripheral sarcomas of the *humerus*, unlike those of the lower extremity, are almost exclusively connected with the

¹ *Bull. de la Soc. Anat.*, 1862, p. 372.

² *Dict. de Méd. Pratique*, vol. xxvii., pp. 741-3.

diaphysis, along which they generally extend at a rapid rate. They manifest, too, a decided tendency to escape through their fibrous capsule and infiltrate the soft structures lying in close proximity to the bone. This local disseminating property should not be overlooked in any amputation which may be undertaken, for a speedy recurrence in the muscles must inevitably take place unless a considerable margin is allowed between the seat of disease and the spot where the operation is performed. Indeed, the rule is to exarticulate at the shoulder in every case of peripheral sarcoma of the humerus, and it would be well always to remove the soft parts freely, leaving little save the skin flaps.

The diagnosis of central from peripheral sarcoma of the humerus may generally be made by observing the position and mode of extension of the growth. Their diaphysial origin and rapid increase along the bone distinguish the peripheral sarcomas. The central tumours, on the other hand, originate usually in or near the upper epiphysis, grow slowly, expanding the bone, and are often accompanied by spontaneous fracture. The history of the growth and its mode of origin will serve to discriminate a subperiosteal tumour from an inflammatory swelling. In any case of doubt an exploratory puncture will complete the diagnosis.

Treatment.—Amputation at the shoulder joint offers the only chance in these cases. The mode in which the disease extends along the shaft forbids any operation through the continuity of the bone.

MR. LUND'S CASE,¹ IN WHICH ONE-THIRD OF THE CLAVICLE, THE WHOLE OF THE SCAPULA, AND THE UPPER EXTREMITY WERE REMOVED FOR SARCOMATOUS GROWTH AROUND THE SHOULDER JOINT.

Case 43.—John Heys, aged twenty, weaver, admitted into the Manchester Royal Infirmary under Mr. Lund's care, September, 1879, for a large tumour of the left shoulder. He was a strong, healthy-looking man, but, unfortunately, when a child had experienced some severe accident affecting the right side of the body, and this had left anchylosis of the right elbow-joint nearly in a straight line with

¹ *British Medical Journal*, vol. ii., Oct. 16th, 1880, p. 617.

the arm, and atrophy of the muscles in those parts from disease. Slight stiffness of right knee-joint from same cause. No family cancerous or strumous disease. Thirteen weeks before admission he had sprained his left shoulder in trying to lift some heavy weight, and in doing so it suddenly swelled so as to prevent him from working any longer on that occasion. Five weeks previous to admission the swelling began to increase very rapidly, and considerable pain was experienced around the shoulder—not along the line of any particular nerve, but a generally-diffused pain which existed at all times, not more by night than by day. Measurements of shoulder: just below the folds of the axilla the circumference was about sixteen inches, and round the arm two inches lower down about thirteen inches. The swelling extended far back, almost beyond the margin of the deltoid muscle, so as to overlap at least one-half of the breadth of the scapula. Movements of shoulder when passively performed were fairly good; but the man had little power to raise the arm himself, and it was noticed that in such movements there seemed to be an undue mobility, and, as far as could be judged, the centre of motion was below the head of the humerus and not in the situation of the glenoid cavity. The swelling seemed to fill the axilla, but no enlargement of glands could be there detected. The pain did not appear to be very intense, although the patient was never entirely free from suffering. The tumour had a firm elastic feel; the skin over it was somewhat stretched, but no fluctuation could be detected at any part. There was no excess of temperature to indicate the presence of suppuration. Under chloroform and antiseptic precautions a pretty deep and long incision was made through the deltoid muscle down towards the centre of the joint. No pus or fluid blood escaped, and a small slice of the tumour was removed. After this the finger was introduced, and then it was found that the upper portion of the humerus was expanded and softened, breaking down readily on the slightest pressure, and on microscopical examination of the piece removed, it was found to be a sarcomatous growth with spindle-shaped cells. Nothing more could be done on this occasion as the patient's consent to amputation had not been obtained. A week later the entire upper extremity, together with the outer third of the clavicle, were removed, and the large wound closed with twenty-four sutures. The after progress of the case was very satisfactory, and by the thirty-sixth day after the operation the wound had completely healed. A dissection of the humerus showed that the upper half was disintegrated by the progress of the sarcomatous disease.¹

Radius and Ulna.—The round-celled form of the disease appears to predominate here. Verneuil met with an example of periosteal giant-celled sarcoma of the lower end of the radius. This is opposed to the teaching of Gross, that myeloid tumours are exclusively central. Peripheral sarcomas of the forearm are to be distinguished from innocent tumours by the

¹ The patient died in September, 1882. On P.M. examination, a large, irregular mass of new growth extending from shoulder to iliac crest was found; it was closely attached to the upper three ribs and spread over apex of the lung; the aorta and inferior vena cava were enveloped in the growth. No deposits were found in any internal organ.



rapidity of their growth, and from inflammatory swellings by their contour being more irregular and abrupt (Butlin). When the growth is extending rapidly it may infiltrate the muscles. It then becomes important to amputate above the attachment of the muscles of the forearm to the humerus. The central tumours, which are rarely found except in the lower third of the radius and ulna, may be treated as already mentioned, by removal of the portion of bone implicated. The results are, however, not very encouraging, and in some cases the operation has been followed by a recurrent growth possessing far more malignant characters than the original tumours. Thus Whitla¹ mentions an example of a myeloid tumour of the radius which took twenty years to grow, and recurred, as a malignant tumour, four months after its removal. Ablation of a central growth of the ulna is a more favourable operation, as it can often be done without opening the wrist joint (Mr. Lucas's case). It is often a matter of considerable doubt whether a particular tumour of the forearm springs from the outside of the bone or is centrally situated. Before undertaking any radical procedure an exploratory incision must be made, when, if the growth is central, and strictly limited within an osseous shell, free removal will often suffice, or should amputation be deemed advisable, the operation need not be practised so high up as in the case of a peripheric sarcoma.

Tumours of the *clavicle* are rare, but it would appear from recorded cases that the malignant are three times as frequent as the simple growths, and the sarcomas (the spindle-celled predominating) constitute the bulk of the malignant tumours. They generally spring from the interior of the bone; in only a small proportion is the periosteum primarily affected.² In a

¹ *Dublin Journal of Med. Sc.*, Oct., 1878, p. 329.

² Mr. Sansom (*Lancet*, 1884, vol. i., p. 563) reports the case of a large subperiosteal mixed-celled sarcoma of the right clavicle, in a man forty years of age, in which, towards the fatal termination, there was a remarkable elevation of temperature, 104°. A secondary growth was found in the left kidney.

very complete table of cases given by Polaillon,¹ only three out of thirty-six cases are described as subperiosteal. Sarcomas of the clavicle occur more frequently in men than in women, and are not confined to any particular age; being met with in the young, in middle life, and in old age. They exhibit a preference for the body or outer extremity of the bone. In size they vary very much, occasionally reaching an immense volume. Some are hard or of elastic consistence, others become soft in the course of their development. Their surface is either smooth or slightly irregular, and the skin over them, although stretched, is healthy and movable; sometimes it thins, and is perforated, when the tumour fungates and bleeds. Some of the clavicular sarcomas have a pulsation synchronous with the pulse, in these vessels of considerable size are found. When such growths occupy the inner extremity of the bone, some care is required in distinguishing them from an ordinary aneurism; the absence of a *bruit de souffle* in the pulsatile tumours has been noted. The want of an expansive movement in the tumour, as ascertained by the sphygmograph, is also of importance (Polaillon). In their growth sarcomas of the clavicle may produce œdema of the arm, from pressure on the subclavian vein. Interference with the functions of the trachea and œsophagus has never been observed. Involvement of lymphatic glands is mentioned in one case only.² Mr. Butlin, on the other hand, found implication of the neighbouring glands in two cases of round-celled sarcoma, situated beneath the periosteum, and occurring in young subjects, both males.

Diagnosis.—At the onset a malignant tumour of the clavicle may be taken for acute inflammation of the bone; the course of the latter, and its frequent termination in the formation of matter, which escapes outwardly, giving rise to fistulæ communicating with diseased bone, will dissipate all doubts.

¹ *Dict. Encyclop. des Sciences Médicales*, 1st série, t. xvii., Art., Clavicule.

² Delore, *Journal de Méd. de Lyon*, 1868, t. ix., p. 26.

Once,¹ at least, the clavicle has been removed for a supposed malignant disease, which afterwards proved to be an example of caries. The chance of any swelling of the clavicle having a syphilitic origin should always be remembered, and, in doubtful cases, the exhibition of antisyphilitic remedies will be deemed advisable. The presence of callus in connection with an overlooked or only slightly-marked fracture may simulate a growth; the course of the affection will clear the diagnosis of all doubt. The distinctions between the simple and malignant bony tumours are the same here as in other parts of the skeleton.

Prognosis and Treatment.—The prognosis in a malignant growth of the clavicle is always grave and unfavourable. In Polaillon's table a cure is said to have been effected in a third of the cases operated upon, but it is doubtful whether these have been followed for a sufficient length of time to warrant such a conclusion. The operations practised have consisted of removal of the portion of bone to which the growth was attached, or total extirpation of the clavicle. In some cases it has been found necessary to remove either the scapula alone, or this bone with the upper extremity, in addition to the affected part of the clavicle. Mr. Skey² removed the greater part of the clavicle for malignant disease. The patient was a man of good general health, and only thirty years of age. The disease began about three years previously, when he noticed a small lump, which was neither tender nor painful. It increased slowly, and caused so little inconvenience that he kept at his duty as a soldier for eighteen months. He had been able to use his arm, but, after using it for a time, he had pain, and the arm felt weak. There was no inequality in the

¹ Potter, *Lancet*, 1849, vol. i., p. 392.

² *Medical Times and Gazette*, 1863, vol. ii., p. 185. Valentine Mott's case, *London Medical Gazette*, February 28th, 1829, should be consulted, as it shows how enormous difficulties encountered during the removal of the clavicle, to which a large sarcomatous growth was attached, may be successfully overcome.

pulses, and apparently the disease was quite limited to the bone. The patient being under the influence of chloroform, Mr. Skey made an incision over the bone, and fully exposed the inner two-thirds. He then divided it by bone forceps about an inch from the acromial end, and afterwards disarticulated at the sternal end. No vessels required ligature. Unfortunately, although the operation was brilliantly executed, the man died ten days later from purulent infection.

When the disease has passed beyond the bone, it is very doubtful whether any operation is justifiable, as the chances of an early recurrence are beyond a doubt. The operation of removing the clavicle is always tedious, and sometimes very difficult. Mr. Sam Cooper took two hours to remove an osteosarcoma which involved the inner two-thirds of the clavicle, and which had also invaded the sterno-mastoid muscle and upper border of the sternum. Mr. Walsham's¹ operation lasted an hour and a half, and was attended with profuse hæmorrhage. Usually the bone is exposed by a longitudinal, crucial, or T-shaped incision, and when the entire clavicle is to be removed we commence by disarticulating its acromial end, then separating it from the most important structures in contact with it behind, and lastly detaching it from the sternum. When the neoplasm occupies a limited portion of the clavicle, it can be removed after division of the bone with a chain saw on each side of the tumour, or section of the clavicle may be combined with disarticulation either at the acromial or sternal ends. Removal of the sternal extremity is manifestly a much more difficult proceeding than extirpation of the acromial end, owing to the relations of the former. Besides a possible injury to the subclavian vessels or the pleura, the operation is attended with special dangers from the entrance of air into the veins. The hæmorrhage during the operation has been sometimes of an alarming character. Such was the case in Mott's patient,²

¹ *Pathol. Trans.*, vol. xxviii., 1875, p. 222.

² *Loc. cit.*

where the arteries and veins severed in the removal of a large ulcerating osteo-sarcoma of the clavicle necessitated the application of sixty ligatures.

Mr. Butlin¹ is of opinion that the results obtained by removal of the clavicle for subperiosteal sarcomatous tumours are not so favourable as to induce one to repeat or recommend it in the future, for the disease speedily recurs and at length proves fatal.

Sarcomas of the *scapula* are usually met with between the ages of twenty and fifty, although examples at the extremes of life are on record. It is often very difficult to state the precise origin of malignant growths connected with this bone. Usually, when cases come under observation, the disease has not only invaded the bone, but implicates the neighbouring soft parts, so that a correct diagnosis as to the exact situation in which the disease originated is well nigh impossible. Producing but slight inconvenience and little pain at first, these tumours often remain unnoticed for a considerable period, and it is only after they have acquired some size that the patient seeks advice. When connected with the superficial surface of the bone, the tumour can be submitted to examination and its rate of increase determined. As the growth enlarges the symptoms become more pronounced, the pains increase, the movements of the limb are more embarrassed, the skin is distended and may exhibit a network of engorged veins. Although the tumour may envelop the shoulder, the scapulo-humeral joint is rarely implicated, the articular cartilage here as elsewhere offering an important check to the extension of the advancing neoplasm.

Both the cases of subperiosteal sarcoma of the scapula mentioned by Mr. Butlin² belong to the round-celled variety. In one of them, reported by Mr. Morgan,³ the disease commenced when the infant was four weeks old, and attacked the acromion

¹ *Op. cit.*

² *Loc. cit.*, p. 56.

³ *Path. Trans.*, vol. xxx., 1879, p. 399. The case appears to be one of general sarcomatous disease.

process of the left scapula as a hard, firm, immovable lump about the size of a nut, to which the skin was not attached. Three days later the lump was considerably larger, and another of a similar character appeared at the lower angle of the same scapula. In the course of two or three days several small tubercles appeared in the subcutaneous cellular tissue of the chest, back, and abdomen; and the child, which had throughout manifested symptoms of severely deranged health, sank rapidly and died comatose five weeks after the original tumour was first noticed. Microscopically the various tumours were found to be made up of densely aggregated masses of cells, for the most part round or oval in shape, but occasionally elongated into a spindle-shaped variety. Looking at the history of this extremely interesting and rare case, one cannot fail to notice the extreme rapidity with which the several tumours followed each other, suggesting a general sarcomatous disease.

When a sarcoma springs from the cancellous tissue between the compact layers of the scapula, it may be mistaken for an exostosis while it is covered by an osseous shell. Soon this gives way and parchment crackling is observed. This, together with the progressive increase in the growth, distinguishes it from an exostosis. The tumour, when it attains to a considerable size, distends and thins the skin, which may ulcerate, allowing the growth to protrude. When this occurs, the general health, previously perhaps little affected, is seriously undermined, and systemic dissemination may take place.

Treatment.—When the disease is recognised early and is accessible, free removal of the implicated portion of bone affords some chance of prolonging life. Complete extirpation of the scapula, with preservation of the arm, has been performed some eighteen times, with sixteen successes as far as the operation was concerned. Nearly all the cases succumbed to a recurrence of the disease within the first year.¹ Resection of the inferior

¹ Demandre, Des tumeurs de l'omoplate de leur diagnostic de leur traitement et des resections qu'elles necessitent. Thèse de Paris, 1873.

angle of the bone is an operation of slight gravity. Removal of the anterior part or the whole of the scapula, with a part of the humerus and clavicle, and sometimes with the entire upper extremity, has been practised; it is a grave procedure, and its utility is not established. In some the operation, although successful at the time, has been quickly followed by a recurrence. Once the tumour has implicated neighbouring soft structures, any attempt at removal must be futile. Mr. Berkeley Hill records a case¹ in which he removed the body of the scapula for sarcomatous tumour, the patient dying of septicæmia forty-five hours after the operation.

Case 44.—The disease occurred in a man twenty-five years of age, and occupied the infra-spinous fossa of the right scapula, forming a rounded prominence most marked about two inches above the angle. The margins of the growth were ill-defined, especially about the posterior border of the bone, which it overlapped; the angle and the supra-spinous fossa were uninvolved. Its surface was broken up into smooth lobules; to the touch it was firm and elastic, deep pressure gave rise to slight pain. The scapula moved freely and painlessly over the subjacent parts, and there was no visible wasting of the muscles attached to it. The skin over the tumour was unaffected, and there were no signs of generalisation of the growth. No history of injury or syphilis. The swelling was first noticed about two months before admission. His grandfather was said to have died of cancer.

Operation. Patient having been placed under the influence of ether, one incision, five inches in length, was made over the posterior border of the bone, and another, four inches long, over the upper border, meeting the first at an obtuse angle. The flaps thus marked out were raised; the muscles attached to the posterior border of the bone were divided, and the latter turned outwards, thus bringing into view the ventral aspect, with a large mass of growth springing from it continuous with that on the dorsum around the posterior border. The upper portion of the spine and the neck were next cleared as far as possible, the former being sawn through near its junction with the acromion, and the latter at about the same level. The muscles attached to the inferior costa, with the subscapular artery, were divided last of all. The whole of the body of the scapula with the growth was thus removed. The operation lasted one hour, and the amount of blood lost was considerable. On dissection of the parts removed, the growth was found to be unencapsuled, resembling brain substance on section (round-celled), widely infiltrating the subscapularis and infra-spinatus muscles; as though during life it was attached to both surfaces of the bone, but covering a larger area of the ventral than of the dorsal surface.

¹ *British Med. Journal*, vol. ii., 1880, p. 659. This case is also reported in vol. i. of the same journal, p. 478.

Demandre, after carefully considering the subject, is of opinion :

1. That in cases where sarcomas of the scapula are clearly limited, an operation is indicated, because a recurrence is not expected for a considerable period.
2. That death from the operation is altogether exceptional, even when the parts removed are very extensive.
3. That a recurrence is more rare and occurs much later after a radical operation, such as total resection or extirpation combined with amputation of the arm.

Jaws.—Sarcomas of the jaws either arise beneath the periosteum or originate within the maxillary bones. Those connected with the alveolar margins are grouped under the term epulis, and have been already mentioned when considering myeloid growths. All varieties of sarcoma have been encountered in connection with the jaws, but the spindle-celled form appears to occur more often than the others, the myeloid alone excepted.

Peripheric or subperiosteal sarcomas are in relation with the external surfaces of the bones, and are made up of fusiform cells collected together in bundles, with an admixture of a certain number of round cells. They form roundish masses, covered at first by the periosteum, which is thickened and changed in appearance. To the naked eye, the tumour on section presents a fibrous appearance. The subjacent bone rarely escapes invasion, generally, it is distinctly eroded. Ossification frequently occurs in this variety of sarcoma, and the condition thus produced is sometimes described as a separate affection, ossifying sarcoma. The osseous needles penetrate the growth in a direction perpendicular or oblique to the surface of the bone. So long as the growth is confined within a periosteal capsule its course is relatively benign, when it passes beyond the limiting membrane its course is much more rapid, invasion of neighbouring structures

then taking place, the disease presenting the clinical features of cancer. Glandular implication in the early stages is unknown. In some instances cystoid cavities have been seen in

FIG. 76.

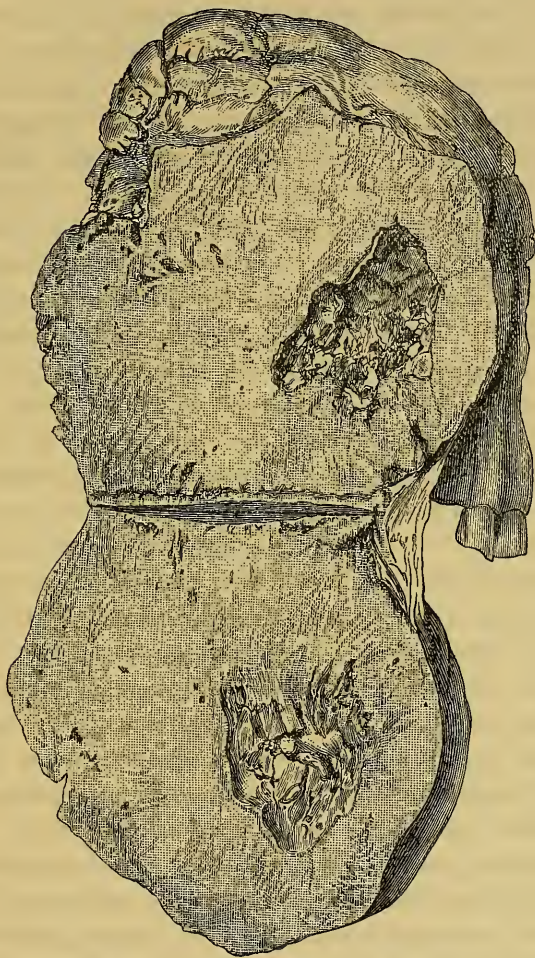


FIG. 76.—Spindle-celled sarcoma of the upper jaw, originating in the antrum (*O. C. Museum*).

the peripheric sarcomas, but these are more often observed in the central growths. In the upper jaw (*fig. 76*) a sarcoma may

develop beneath the lining membrane of the antrum, grow into this cavity, extend to the other superior maxillary bone across the median line, and even invade other bones of the face.

A very large proportion of the *central sarcomas* of the jaws belong to the myeloid variety, first described by Paget in 1853.¹ Prior to this, Robin (1849) had called attention to the fact that certain tumours of bone were largely composed of the myelo-plaxes which he had observed in the marrow of bones in the normal state. Two distinct forms of the myeloid sarcoma, as observed in the jaws, are mentioned. In the first or encysted intra-osseous tumour, there is a circumscribed mass enclosed in a distinct cavity, surrounded by an osseous shell which varies in thickness with the size of the contained tumour. In the second variety, there is no clear line of demarcation between the diseased and healthy tissues, the growth filling the dilated spaces of the spongy structure. Both varieties may undergo cystic changes, and the disease is then often designated cystic sarcoma; a microscopical examination will, however, show the character of the tissue in which the degeneration has gone on. Myeloid central growths possess evident vascularity, which, on section of the tumour, is often exhibited in the form of small patches of hæmorrhage. As the myeloid sarcomas increase in size they perforate the bone, and often appear on the outside under the integuments or mucous membrane, and later they may even ulcerate through these coverings. By preference myeloid sarcomas grow from the alveolar margins; often they soon appear as epulides, or they may remain within the bone for a considerable time. Besides these common growths, an infiltrating form of central sarcoma is met with, the tissue of which is made up largely of round cells—the encephaloid variety. This variety grows rapidly, often reaches a large size, and may fungate through the skin. Fasciculated sarcomas also form central growths in the jaws.

¹ A most complete account of myeloid tumours will be found in Nélaton, Thèse de Paris, 1860; also Gray, On myeloid and myelocystic tumours of bone, *Med. Chirurg. Trans.*, 1856, vol. xxxix., p. 121.

Sarcomas of the jaws occur mostly before forty years of age, the myeloid being generally found in younger people, and often in children. These tumours have to be distinguished from chondromata and fibrous growths, sometimes met with in the jaws. The consistence of the growth will assist in the discrimination. The hardness of the simple tumours is almost invariably very decided, while the sarcomas present a softness bordering on fluctuation in some cases. This is chiefly true of the peripheral growths and the epulides. In the intra-osseous form, the growth as it increases expands the bone, and when the osseous shell is thin, egg-shell crackling may be present. In some cases perforation is rapidly produced, the tumour then becoming extra- as well as intra-osseous. The rate of increase varies much in sarcomas of the jaws, some, and these constitute the majority, grow slowly, remain of very limited extent for a considerable period, and are unattended by any alteration in the health; in these the affection, which may be looked upon as local, occasions little inconvenience. Others attain a large size in a short period, the buccal mucous membrane is stretched over the growth and ulcerates, the skin offers more resistance but is sometimes perforated, some slight glandular implication may occur about this period, and the general health usually suffers. Tumours largely composed of round cells are the most malignant, and these are the cases formerly grouped together as cancers.

From what has already been said it will be evident that the prognosis in sarcomas of the jaws must vary very much. The myeloid growths do not recur after complete removal, the other tumours exhibit degrees of malignity in proportion to the rate of growth and the tendency to implicate neighbouring tissues. When a tumour grows rapidly and extends beyond its limiting capsule, whether bony or fibrous, the gravity of the case will be very marked.

The treatment will consist in removing the whole of the sarcomatous growth, with the portion of bone to which it is

attached. In peripheric growths, when seated on the outer side of the bone, mere removal of the growth, with scraping and cauterisation of the point of attachment, has been practised. This is rarely sufficient, the better practice will be to resect the bone in such cases. In the sarcomatous epulis removal of a V-shaped piece of the alveolar border, including the growth, together with a sufficient amount of the surrounding bone to ensure complete extirpation, is the treatment indicated. When the tumour extends deeply into the jaw, we should not hesitate to remove the entire bone involved. In the upper jaw, when the tumour occupies the antrum, the whole bone must be sacrificed. It is sometimes recommended in such cases that the orbital place should be left, its under surface being carefully scraped. This is doubtful advice, the growth is very liable to recur in this situation; so that, as a rule, complete removal is the better plan.

Skull.—Primary or secondary, metastatic, sarcomas may develop, either on the outside of the vault (*fig. 77*) on its inner surface or in the diplœe. They occur at all ages,¹ although most frequently observed in the adult. Males are attacked more often than females. The encephaloid or round-celled variety predominates, but examples of all the other forms have been described. A peculiar variety of sarcoma, to which the name of chloroma was first given by Lenoir and Aran,² is met with in this situation. It is a round-celled tumour, occurring under the periosteum of the skull, is often multiple, and on section, presents a light green or dirty brownish-green tint. The colour soon fades on exposure to the air. It has been suggested that the colouring matter of the blood, which is

¹ Mr. Jessett (*British Med. Journal*, 1884, vol. i., p. 62) records a case of medullary sarcoma of the skull in an infant of nineteen months.

² Note, Sur une forme partic. de cancer de la dure-mère, chloroma, *Archiv. Gén. de Méd.*, 1854, 5^e série, t. iv., p. 385. See also Huber, *Archiv der Heilk.*, 1878. Also Balfour, *Edin. Med. and Surg. Journal*, vol. xli., p. 319; and cases in *Lancet*, 1883, vol. i., p. 696; 1885, vol. ii., p. 83.

extravasated or remains stagnant in the obliterated capillaries, has undergone a change, the nature of which still remains undetermined. It usually runs a most rapid course, and produces growths of similar structure and appearance in distant parts—bronchial and mesenteric glands, kidneys, prostate, testes, breasts, lungs, and kills in from three to six months (Butlin). Often the skull is invaded in several situations at the same time by sarcomatous tumours, and accompanying them will

FIG. 77.



FIG. 77.—Subperiosteal sarcoma springing from temporal bone.

often be witnessed an inflammatory action in the neighbouring portions of bone. A rarefactive osteitis is thus induced, and, in some instances, sequestra have been eliminated.

Symptoms.—Fixed, lancinating pains may precede the appearance of a cranial sarcoma. When the disease is on the outer side of the bone, one or more swellings of varying consistence will be detected. As the tumours increase in size they become softer, and not unfrequently a sensation of false fluctuation is present, giving rise to difficulties in diagnosis. A further source of embarrassment exists when cysts form, either from degeneration or in consequence of changes in

hæmorrhagic centres. Then the question of a subperiosteal abscess will often arise. When a sarcoma of the skull commences in the *diplœ*, the inner and outer tables are separated and destroyed by the advancing neoplasm, which projects at the same time on the outer and inner surfaces of the cranium. Under these circumstances, by exercising pressure on the growth, its partial disappearance may be effected, while a pulsation synchronous with the arterial pulse may be discovered at the same time. An intracranial growth, whether springing from the inner table or forming part of that originating in the *diplœ*, often induces cerebral symptoms—vertigo, convulsions, paralysis—yet death from pressure on the brain is comparatively rare (Butlin). Sometimes the brain symptoms are produced, not by the growth itself, but by an inflammation occasioned by its presence.

Diagnosis.—At the onset often most difficult, particularly when the growth commences in the *diplœ* or on the inner surface; severe pain, confined to one part of the head, is a suspicious symptom in the presence of a sarcomatous tumour in some other part of the body. When the disease is subperiosteal, the swellings may be taken for specific nodes or bony abscesses. To distinguish them from the former, the history and the absence of any other manifestation of syphilis will generally suffice. In case any doubt still remains, the aid of antisyphilitic remedies may be advantageously invoked. Exploration with a syringe will settle the question of an abscess. The very vascular sarcomas bear a considerable resemblance to certain erectile tumours of the scalp, and the possibility of a mistake must always be kept in view. The latter are generally the seat of pulsation, which ceases on pressing the carotid; this, combined with the history of the swelling, will prevent any error.¹

¹ Mr. Henry Morris, *British Medical Journal*, 1880, vol. i., p. 402, gives the case of a woman, aged forty, in whom pulsating tumours occurred on the cranium and elsewhere. Considerable difference of opinion existed in regard to the nature of the new growths, they were probably sarcomatous.

Course, Prognosis, and Treatment.—The course of cranial sarcomas varies much, generally those forms which arise secondarily or are metastatic develop rapidly. There is but one termination, and that is death in all cases; this may or may not be preceded by symptoms pointing to the cerebral centres being implicated. The disease is therefore incurable, and palliative treatment is the only justifiable one. It is just possible that removal may offer some chance of relief in those cases in which the disease is subperiosteally situated, and when operative interference is undertaken at an early period. The probability of the growth appearing simultaneously on both surfaces of the skull should, however, be remembered whenever any attempt at removal is contemplated. This fact, together with the utter inutility of trying to arrest the progress of the disease by operation, should, as a rule, dissuade us from interfering. The frequent multiplicity of the growths is an additional argument against operation.¹

Pelvis.—Sarcomas may spring from any part of the pelvis, but they generally attack the innominate bones. They are either primary, which is most frequent, or may appear as metastatic growths. Sarcomas connected with the pelvis possess some important characteristics which invest them with more than ordinary interest. They not unfrequently pulsate, and when situated near the course of the large vessels the distinction between them and ordinary aneurism becomes a matter of great difficulty. That this is so will be apparent when it is mentioned that surgeons of unusual eminence have ligatured arteries under the impression that they were dealing with an aneurism, when the tumour has subsequently proved to be a pulsating growth connected with the bone. Again, sarcomas of the pelvis are prone to dissemination; the metastatic

¹ Cases of sarcoma of the skull are reported by Abercrombie, *British Med. Journal*, 1879, vol. ii., p. 817; Gross, *Philadelphia Med. Times*, xi., 1880, p. 184; Bryant, *Lancet*, 1883, vol. i., p. 142.

growths, similar in all respects to the parent growth, being often found in the lungs. This predilection for the lungs appears to be due to the fact that generalisation is most often produced by an embolic mechanism, portions of the growth having been discovered in the iliac veins. The following very interesting case, reported by Dr. Fussell,¹ shows the distribution of the metastatic growths.

LARGE SARCOMA OF LEFT ILIUM; SARCOMATOUS THROMBUS OF LEFT COMMON AND EXTERNAL ILIAC VEINS; SARCOMATOUS EMBOLA IN RIGHT VENTRICLE OF HEART AND RIGHT LUNG.

Case 45.—J. M., aged thirty-three, admitted into the Sussex County Hospital, February 5th, 1879. He had been suffering from pain in his left hip for nine months, and had been treated during this time for sciatica. He had had three successive attacks of shivering. A week or two before admission, he noticed some swelling about the left hip for the first time, and he was quite unable to bear any weight on the limb. He stated that he had never suffered from rheumatism, and had always enjoyed good health. There was no family history of cancer. On admission, he was sallow and poorly nourished, having, he said, lost flesh during his illness, and his expression was anxious. He complained of shooting pains from his left hip downwards to the foot, which prevented him from sleeping. The left foot, leg, and thigh were œdematous, and there was found to be great swelling with induration over the haunch-bone of this side; the swelling being hot, tender, and painful. There was also some fulness with tenderness in the corresponding iliac fossa; no glandular enlargement discoverable. He was kept in bed, morphia was administered hypodermically to relieve the pain, and castor oil to act on the bowels, which were costive. The swelling gradually increased, assuming very large proportions; his lower extremity became numb, and he grew more emaciated. Eventually, in about a fortnight or three weeks' time, well-marked signs of pleurisy and pneumonia were developed on the right side of his chest, followed by great prostration and distress. Finally, symptoms of pneumothorax occurred on the same side of the chest, and, about the same time, rather profuse melæna took place. From this date (March 3rd), he quickly sank, and died on the 5th, one month after admission.

Post-mortem Examination.—The growth occupied the dorsum ilii and the iliac fossa, and was hard and firm. It was found to spring from the whole of both surfaces of the ala of the ilium, to which it was quite limited and which it had eroded, though not actually perforated. On cutting into it, the mass was white and suety in appearance, and firm and hard throughout, except for a small extent in its interior, where it had softened down into a pulpy cavity containing a clot of blood. Distributed through its substance was a quantity of bony or calcareous material. Microscopical examination of the tumour showed it to be a specimen of sarcoma,

¹ *Lancet*, vol. i., 1880, p. 207.

composed of a dense matrix of fibroid tissue, with cells of various sizes and shapes, mostly rounded, but some angular, spindle-shaped, and caudate; some with large well-marked nuclei, and others with indistinct granular contents embedded in it. In most places calcareous granules were scattered, but no true bone cells were discovered. The nerves in the neighbourhood were pressed upon; the external and common iliac veins (left) were also compressed; and were blocked internally by a large white flattened mass, suety in appearance, hard and irregular on the surface. Microscopically this was found to consist in part at least of sarcomatous tissue, presenting roundish nucleated cells of considerable size interspersed in an indistinct or slightly-fibrillated stroma. It was lying loose in the lumen of the vessel, the walls of which were not invaded. The upper part of the femoral vein contained a somewhat similar but softer mass, more like an ordinary coagulum (not examined microscopically). Lumbar glands not enlarged. Right pleural cavity was the seat of a pyo-pneumothorax. Uppermost lobe of right lung, which was collapsed, was completely solidified, of a greyish colour, granular on section, and yielding when pressed a thick purulent fluid—was, in fact, in a condition of grey hepatisation and purulent infiltration. Near the posterior surface of middle lobe was a small hard pinkish nodule, pale and granular on section, not encapsuled, but imbedded in the pulmonary tissue itself, evidently a secondary deposit of sarcoma. Emboli of sarcomatous tissue found in the branches of the right pulmonary artery. In the right ventricle of the heart was a partially-decoloured clot of some size. On pressing this, a long white pedunculated or polypoid mass about two and a half inches in length, with a somewhat rounded head and a long stalk, not unlike a barnacle, started out from the centre. This was quite firm, irregular on its surface, having a somewhat twisted or annulated appearance exactly resembling, except in point of size and shape, the suety bodies found in the branches of the pulmonary artery in the right lung. It was quite unattached to the walls of the heart, and was evidently of embolic origin, derived from the mass in the iliac vein. Microscopically it was seen to be composed of cells mostly roundish, but some irregular, of various sizes scattered through a fibrillated stroma having a structure, therefore, identical with that of the bodies previously described. Bones, as far as they were examined, found healthy.

It is observed that the lymphatic glands are often implicated in the growth of pelvic sarcomas. This usually happens in those cases where the new growth is devoid of any limiting capsule, and extends without opposition into neighbouring glands, which become incorporated with the advancing neoplasm.

The difficulties attending the diagnosis of pulsating tumours of the ilium are generally great, and sometimes insurmountable. In the following case a ligature was placed around the common iliac artery, under the impression that the disease was an ordinary aneurism

PULSATING TUMOUR OF THE ILIUM. LIGATURE OF THE COMMON ILIAC ARTERY. MR. STANLEY'S CASE.¹

Case 46.—A man, aged forty-two, of short stature and rather thin, was admitted into St. Bartholomew's Hospital, January 18th, 1845. During the last four years he had suffered at times from pain in the left hip-joint and back part of the pelvis, which was supposed to be from rheumatism and sciatica. The sensation communicated to the finger placed upon any of the larger arteries was that of the vessel being preternaturally large, and of its beats being accompanied by a powerful vibration. The pulsating tumour was situated on the left side of the pelvis, its chief connection being with the ilium in about the anterior half of its extent; it projected from both surfaces of the ilium (a suspicious circumstance in itself of the osseous origin of the swelling), but more considerably from its abdominal surface, and it extended upwards to the crista. From the abdominal surface of the ilium the tumour extended downwards to Poupart's ligament along its outer half, and into the cavity of the abdomen towards the mesial line. The tumour felt everywhere moderately firm, and, when compressed, it did not distinctly recede. The portion of the crista of the ilium which bounded the tumour superiorly was uneven and thickened, and a little below the crista, near the anterior superior spine, a small movable piece of bone was discovered apparently involved in the tumour (another symptom pointing to a bony origin). Everywhere within reach of the fingers the tumour pulsated not with a thrill or vibration, but with the deep, heavy beat of aneurism. In the portion of the tumour projecting from the dorsum of the ilium the pulsation was less forcible than elsewhere. By the ear resting against the abdominal parietes, a bellows-sound in the tumour was plainly recognised. The external iliac artery could be traced by its pulsations along the inner side of the tumour. Compression of the lower part of the aorta stopped the pulsation of the tumour. Compression of the femoral artery below the tumour produced an immediate enlargement and increased tension of it. After considering all the circumstances, it was concluded at a consultation that the disease was an aneurism, and the iliac artery was accordingly tied. At the operation, after securing the common iliac, an artery was discovered pulsating forcibly at the upper part of the tumour. This led Mr. Stanley to be apprehensive that the disease was something more than ordinary aneurism. The patient died on the morning of the third day after operation, and, on examining the pelvis, it was found that the portion of tumour projecting into the abdomen had displaced the external iliac artery from the walls of the pelvis, but that this artery had no other connection with the tumour than by loose cellular tissue. The internal iliac artery and its branches were in their natural situation, and wholly unconnected with the tumour. The abdominal surface of the tumour was covered by the iliacus internus muscle, and the portion of it projecting from the dorsum of the ilium was covered by the gluteus medius. Beneath these muscles the periosteum of the ilium, much thickened, was extended over the tumour, excepting in its central and most prominent part, where, the periosteum having been absorbed, the substance of the tumour was in contact with the contiguous muscles. A tumour similar in structure to the one springing from the ilium existed in the inner side of the right upper arm, very loosely connected with the surrounding textures.

¹ *Medico-Chir. Trans.*, 2nd series, vol. x., 1845, p. 317; also referred to in Mr. Stanley's work, *Diseases of the Bone*, London, 1849.

Billroth¹ records three instances of pulsating sarcoma of the pelvis, two occurring in females and one in a male.

PULSATING SARCOMATOUS TUMOUR OF THE ILIUM, SECONDARY TO A SARCOMA OF THE SCAPULA; NODULE IN THE LIVER.

Case 47.—George S., æt. forty, admitted into the Manchester Royal Infirmary, March 20th, 1884. Until about two years ago, enjoyed good health. Then he complained of pain of an aching character in right shoulder blade. It was worse after exertion, and was looked upon as of a rheumatic nature. After the pain had existed about two months, an enlargement appeared. It was under the scapula, and increased very rapidly. It pulsated from the first, was not very tender, but it interfered with the movements of the arm. The growth, together with the lower angle of the scapula from which it sprang, was removed twenty months ago. Fifteen months later, he noticed pain in the left gluteal region, with some stiffness in moving the leg, and fatigue on comparatively slight exertion. The pain was of an aching character, very similar to that previously experienced in the shoulder. He was treated for rheumatism, but with no improvement. About the beginning of 1884, he felt a swelling in the same region. It was pulsatile and increased rapidly. He also suffered from shooting pains down the limb, and these at times have been most troublesome. A large globular tumour was found in the gluteal region, extending upwards as far as the crest of the ilium, and downwards to the level of the sacro-sciatic notch. Anteriorly it reached to a little in front of a point midway between the anterior and posterior iliac spines. It measures four and a half inches from above downwards and five inches from side to side. The skin over the tumour is quite normal in appearance and not adherent in any part. The growth itself is firmly fixed to the bone, and, on placing the hand upon it, a distinct pulsation synchronous with the pulse is felt, and, on pressing the upper border of the tumour, there is very distinct egg-shell crackling. On auscultation, there is a distinct systolic bruit heard, most evident where the pulsation is most marked, viz., over the upper border of the swelling. The liver is very much increased in size, the increase chiefly affecting the right lobe. On palpation of the abdomen, a smooth rounded tumour can be felt projecting downwards from the lower margin, and lying to the right of the umbilicus. No pulsation and no bruit can be detected in it. There is no jaundice. The other organs appear normal. On examining the back, there is a T-shaped cicatrix over the situation of the lower angle of the right scapula. The lower third of the bone has evidently been removed, and the abrupt lower border that remains can be distinctly felt. A few months later the patient died, but unfortunately no post mortem could be obtained.

In the differential diagnosis² of pelvic tumours that pulsate, attention should be specially directed to the following circumstances :—

¹ Clinical Surgery, *New Sydenham Society's Trans.*, p. 334.

² See a paper by Mr. Holmes, On the diagnosis of aneurism, *St. George's Hospital Reports*, vol. vii., p. 173.

1. The position of the swelling; in the only two cases that I have seen the tumours were superficial, and so placed that the diagnosis was comparatively easy. When, however, the growth is on the abdominal surface of the ilium, the difficulties will be much greater. In such a case, careful palpation through the anterior abdominal wall, while the patient is lying down and anæsthetised, combined with a rectal, and in the female a vaginal, examination, will often throw a light on the nature of the tumour.

2. The presence of bony plates in the sac, or the discovery of parchment crackling on pressure, are in favour of the osseous origin of the tumour.

3. The projection of a pulsating tumour from both surfaces of the ilium usually indicates its connection with that bone.

4. No definite conclusion can be deduced from the character of the pulsation, for in a sarcoma of the pelvis, on putting the ear to the tumour the whizzing sound attendant on the flow of blood into an aneurism can be very distinctly heard.¹

Treatment.—In sarcomas of the pelvis the treatment should be palliative; all attempts at removal of the growth must terminate unsuccessfully. The pain associated with extension of the tumour is to be relieved with the subcutaneous injections of morphia, and possibly by the application of cold (Billroth). I tried galvano-puncture in one case, but my interference did not in any way diminish the pain.

¹ This was the condition observed in Mr. Guthrie's case (*London Medical and Surgical Journal*, August, 1834) of pulsating tumour of the ilium, in which the common iliac artery was ligatured under the impression that the disease was aneurismal.

CHAPTER XVI.

CARCINOMA OF BONE.

Cancer may attack a bone in three distinct ways: 1. As a primary disease (very rare). 2. In the form of secondary or metastatic deposits (most frequent). 3. By direct propagation from the soft parts; in this event the disease is most frequently an epithelioma.

The occurrence of primary carcinoma of bone has been denied by many histologists; still there are a few well-authenticated cases on record which leave little or no doubt as to the existence of such a disease. Most of those who refuse to admit that cancer can affect a bone primarily, contend that a primary disease in some other part of the body has been overlooked; or that the soft tumours of bone, usually called cancers, and having an alveolar arrangement, are to be regarded as alveolar sarcomas, due to a higher evolution of the lymphadenoid type of tissue.

Primary cancer is prone to attack the bones of the cranium and face, especially the superior maxilla, the pelvis, the vertebral column, the sternum, and the articular extremities of the long bones. In a case mentioned by Wilks and Moxon,¹ the basilar bone was the chief seat of the disease, which had extended to the jugular foramen and destroyed the pneumogastric and spinal accessory nerves. Usually in the skull the affection attacks the vault and forms multiple, soft, rapidly-growing nodules, originating in the diplöe and extending as they grow through one or both cortical layers. Sometimes

¹*Pathol. Anat.*, p. 61.

when the calvarium is removed, portions of growth adhere to the dura mater, giving the impression that the nodules are connected with it. Most frequently the primary carcinoma is circumscribed and intra-osseous, the bony structure being replaced by carcinomatous tissue. This may proceed to such a degree that the bone is completely destroyed and a fracture occurs. In all cases the articular cartilage offers a very effective opposition to the cancerous disease penetrating an articulation, and the synovial membrane exhibits but a very slight tendency to be attacked either by a primary or secondary carcinoma. In an example of disseminated cancer of the cranium and other parts of the body exhibited to the Pathological Society, in 1882, by Dr. Moxon, the tumours showed a colloid structure.

The diffuse carcinomatous infiltration, described by Förster,¹ appears to commence in the vertebral column where the alveolar spaces of the spongy osseous tissue are filled with cancer elements, the osseous trabeculæ, at first intact, gradually atrophy and disappear, so that the bone is very easily cut with a knife; other bones become affected, especially the pelvic bones, also sometimes the ribs, calvarium, and limbs. Owing to the changes in the bones, curvatures and deformities result, not unlike those observed in osteomalacia, hence the disease is often called *carcinomatous osteomalacia*.² Volkmann recognises an osteoid carcinoma in which partial ossification with the production of spurious bone tissue is observed. This variety may arise in the interior of a bone, or, what is much more frequent, beneath the periosteum. The metastatic tumours to which these osteoid carcinomas are apt to give origin are found generally in the lungs, and present, in most cases, evidences of ossification.³

¹ Ueber die Osteomalacie bei Krebskranken, *Würrzb. Med. Zeitschr.*, 1861, Bd. ii., S. i.

² In Pitha and Billroth's *Handbuch der Chirurgie*, Bd. ii., Abth. 2, p. 471, will be found a remarkable illustration of this diffuse form of cancer attacking the femur.

³ Pitha and Billroth, *loc. cit.*, p. 469.

2. Metastatic or secondary cancer¹ of bone is much more often observed than the preceding variety, and is especially apt to succeed carcinoma of the breast, sometimes of the uterus and rectum, rarely the primary cancer of the superior maxilla. The deposits of cancer, which are often very numerous, rapidly destroy the bone, though they seldom produce appreciable tumours. Occasionally the secondary carcinoma assumes the diffuse infiltrating variety. A bone affected with metastatic cancer may present on maceration, large, irregular holes, observed most often in the pelvis and calvarium. When cancer of the breast has existed for some time, it is not uncommon for the patient to complain of intense localised pain in the back, usually indicative of secondary deposits in the vertebral column. The cancerous tissue may replace the body of a vertebra, often without producing any appreciable alteration in the shape of the spine. In cases where the carcinomatous disease attacks several vertebræ, the loss of substance is such that a deformity similar to that observed in Pott's disease is witnessed. Both primary and secondary cancer may produce spontaneous fracture of the long bones from replacement of the osseous tissue by the metastatic deposit, or the cachexia may produce a condition resembling osteomalacia. In these cases, according to Cornil and Ranvier, no union occurs, the irritation merely leading to the transformation of neighbouring tissues into cancer tissue.

ATROPHIC SCIRRHUS OF LEFT BREAST; PULSATING TUMOUR (CANCEROUS) OF LEFT TIBIA.

Case 48.—Caroline B., æt. fifty-six, admitted into the Manchester Royal Infirmary, January 28th, 1884. No history of cancer in any members of her family. She has been married thirty-six years, and has had three miscarriages and no children. No evidence of syphilis. For nearly three years she has noticed lancinating pains in the left breast, and soon afterwards a small lump, the size of a hazel-nut. It increased in size and the pain intensified, until about twelve months ago, when the skin over the lump began to assume a wrinkled, reddish appearance. About the same time the left leg commenced to pain very much, the skin over the

¹ Leuzinger, *Die Knochenmetastasen bei Krebs*, Zürich, 1886, contains some very valuable information.

swollen part began to assume a reddish appearance, and became hot and painful. It was treated for inflammation, and all the symptoms subsided, with the exception of the pain, which was severe, especially in walking. Six months before admission she noticed pulsation in the lump. Since the trouble in the leg has commenced, the breast has given no inconvenience, and has become decidedly smaller. On the inner or subcutaneous surface of the tibia, a little above the centre of the leg, there is an elongated swelling, from one to two inches in length, not very prominent, but with distinct pulsation in its upper part, very painful on pressure. An inch higher there is a second smaller, non-pulsating swelling. The tibia in the situation of the larger swelling has given way, and on moving the limb crepitus can be easily elicited. The limb was fixed with felt, the tumour being left uncovered, and evaporating lotion applied. Under this treatment the pain subsided very decidedly, and the swelling at the same time became less distinct. The change proved to be of a very temporary character, the area of pulsation increased, and with it there was an increase in the pain. Amputation was discussed, but promptly refused by the patient. She left the institution, and died a few months later. Unfortunately, no examination of any kind could be obtained.

Symptoms and Diagnosis.—The symptoms of carcinoma of bone bear a close resemblance to those attending sarcoma; indeed the clinical differentiation of the two affections is often extremely difficult. The accompanying incidents will be found helpful. The presence of a breast tumour having the character of a carcinoma when followed by a fixed pain, pulsation, and spontaneous fracture of a long bone, would constitute a clinical picture difficult to mistake. The pain attending cancer of bone, especially when it affects the spine,¹ is usually very severe and persistent, and is of itself a symptom of considerable significance. When the metastatic tumour has assumed a certain size its consistence varies much; in some cases it is so soft as to give rise to the supposition that an abscess is present, and this assumption is strengthened by the presence of false fluctuation and evidences of inflammation in the superficial structures. Egg-shell crackling is extremely rare in bone carcinomas, but pulsation and a bruit de souffle have been frequently observed. Volkmann² gives an instructive

¹ For a table of cases, &c., of Cruveilhier's "paraplégie douloureuse," from malignant disease of the spine, consult *New York Med. Journal*, Feb. 26th, 1887, p. 225.

² Pitha and Billroth's *Handbuch der Chirurgie*, Bd. ii., Abth. 2, p. 475.

case of primary cancer of the neck of the femur treated for coxalgia, and later, when a fracture occurred, a spontaneous luxation was suspected. A post-mortem examination declared the presence of cancer. One point of difference between bone cancer and bone sarcoma will be found in the more frequent implication of lymphatic glands in the former than in the latter. Again, cancer attacks patients more advanced in years, its course is more rapid, pain is more severe and persistent, and the soft parts, including the skin, are more often invaded. The diagnosis of secondary cancer in bone will be largely influenced by the discovery of a primary carcinoma. In any case, therefore, of malignant tumour of bone of doubtful nature, a search for cancerous disease in other situations should be at once made.

Prognosis.—Cancer of bone always terminates fatally. Holmes states the average duration of life between the appearance of the first symptoms and death to be a year and a half. Even when the affected part is removed recurrence always takes place, and rapid generalisation to the internal organs after operation is often observed.

Treatment.—It is very doubtful when the diagnosis of a bone carcinoma is certain, if any operation is justifiable. As, however, it often is impossible to tell beforehand whether a case is a primary carcinoma or sarcoma, the same rules of treatment apply to both diseases, disarticulation above the diseased bone being in carcinoma always preferred to amputation through it.

EPITHELIOMA OF BONE.

This is generally produced by extension of epithelioma from the soft parts in which it has developed. Epithelial cancer of the lower lip or of the mouth may extend to the jaw, which it invades and destroys. The disease has also been observed in the leg,¹ attacking the tibia by direct propagation from the

¹ Shrady, Epithelioma of leg extending to medulla of tibia, spontaneous fracture, supra-condyloid amputation, *New York Medical Record*, 1885, p. 274.

skin, which has undergone cancerous changes. Follin, in removing a large cancrroid from the cicatrix of a burn on the back of the forearm, found that the ulna was involved in the disease. Cancerous affection has been discovered implicating cloacæ leading down to necrosed bone (Nicoladoni¹). In these cases, which are allied to primary cancer of bone, the affection progresses slowly, and has little or no tendency to affect the external soft parts. Reclus² has described a peculiar form of epithelioma, boring or burrowing, attacking the upper jaw, which appears as a large cavity lined with exuberant epithelial granulations. This variety of epithelioma, *épithéliome terebrant*, generally commences with a persistent toothache, has a very rapid course, and originates, according to Verneuil, in one of the small cysts so often attached to the root of the teeth. The disease may also commence in the antrum, or, arising in the nose, may secondarily invade the antrum (Heath).

All the varieties of epithelioma have been described in bone. Tubular paved epithelioma is common in the upper jaw, spreading either from the antrum or the soft palate, and squamous epithelioma, originating in the gums or mucous membrane of the palate, readily extends to the neighbouring bones. In a case of epithelioma, beginning in the floor of the mouth, near the frænum linguæ, the lower jaw became extensively implicated. A large portion of the entire thickness of the bone was removed with the growth. There was no recurrence in the bone or in the mouth, but, in the course of the next eighteen months, the lymphatic glands in the neck, even as low as the clavicle, were converted into large-knobbed tumours. A temporary improvement followed their removal, the man eventually dying from cancerous ulceration of the neck.

¹ Epitheliombildung in Sequesterladen, *Archiv f. klin Chir.*, 1881, Bd. xxvi.

² *Progrès Médical*, 1876, p. 795, the first case in this country, by Mr. Lawson, *Trans. Clin. Soc.*, 1873, vol. vi., p. 20; see also Butlin, Squamous celled epithelioma of upper jaw, *Path. Soc. Trans.*, L., 1882, vol. xxxiii., p. 327; also *ibid.*, 1881, vol. xxxii., p. 212.

Treatment.—The treatment of epithelioma will depend on its seat and extent. When affecting the jaws free removal of the diseased portions must be adopted, and in some cases, owing to the extent to which the disease has penetrated, even this procedure will not succeed. It may be found necessary to sacrifice the upper jaw if the cancerous affection has passed the limits of the alveolar margin; also when the bone is the seat of the boring epithelioma of Reclus. In the lower jaw large portions of the body of the bone may be excised with impunity, leaving a good result; after removal the surfaces should be maintained in apposition by a silver wire. In other parts of the body, the implicated soft structures, must be removed, and the invaded bone freely gouged away until healthy tissue is exposed. In case the disease is too extensive to permit of this practice being adopted, or if it recurs, amputation will be the proper course to pursue, and the need for carrying out this proceeding far above the limits of the lesion are not so urgent in epithelioma as in other malignant tumours of bone.

The following must be regarded as an altogether exceptional instance of cancer affecting a bone primarily :—

PULSATING GROWTH (PRIMARY EPITHELIOMA) OF CREST OF ILIUM; DEATH;
RESULT OF THE POST-MORTEM AND MICROSCOPICAL EXAMINATION OF
THE TUMOUR.

Case 49.—William Mc. C., aged fifty-one, admitted into the Manchester Royal Infirmary, March 23rd, 1885. About four months ago, he experienced pain in the right side of the pelvis, first observed during a protracted fit of coughing. A swelling soon followed, the pain also increasing. He is an anæmic man, with some consolidation of the apex of right lung. On the right ilium, a little below centre of crest, is a hard, irregular, ill-defined tumour, which is tender at certain spots, and which distinctly pulsates. A bruit is also audible. No signs of tumour in any other situation. A few days after admission patient had a sharp attack of hæmophyses, which further diminished his rapidly declining strength. He soon fell into a comatose state, and died on April 8th. The post mortem was conducted by Dr. Harris, who found a tumour which proved to be an epithelioma arising from the ilium; a careful examination of all the organs showed the absence of malignant disease. This must be, therefore, regarded as a case of primary cancer of bone, and this opinion is shared by Professor Dreschfeld, who has been kind enough to examine the sections.

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